HEATING & VENTILATING
AIR CONDITIONING

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FOR SEPTEMBER, 1936

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For Engineers and Contractors Controlling the Design, Specification, Installation and Maintenance of Heating, Ventilating and Air Conditioning.

HEATING & VENTILATING is published monthly by The Industrial Press, Robert B. Luchars, President; Edgar A. Becker, Vice-President and Treasurer; Erik Oberg, Secretary. Published at 148 Lafayette Street, New York, N. Y. Western Office, 228 North La Salle Street, Chicago, Ill. Yearly subscription in United States and Mexico, $2.00; in Canada, $2.50; in all other countries, $3.00. Single copies, 30 cents. Member of Audit Bureau of Circulation and Associated Business Papers.

VOLUME 33 NUMBER 9

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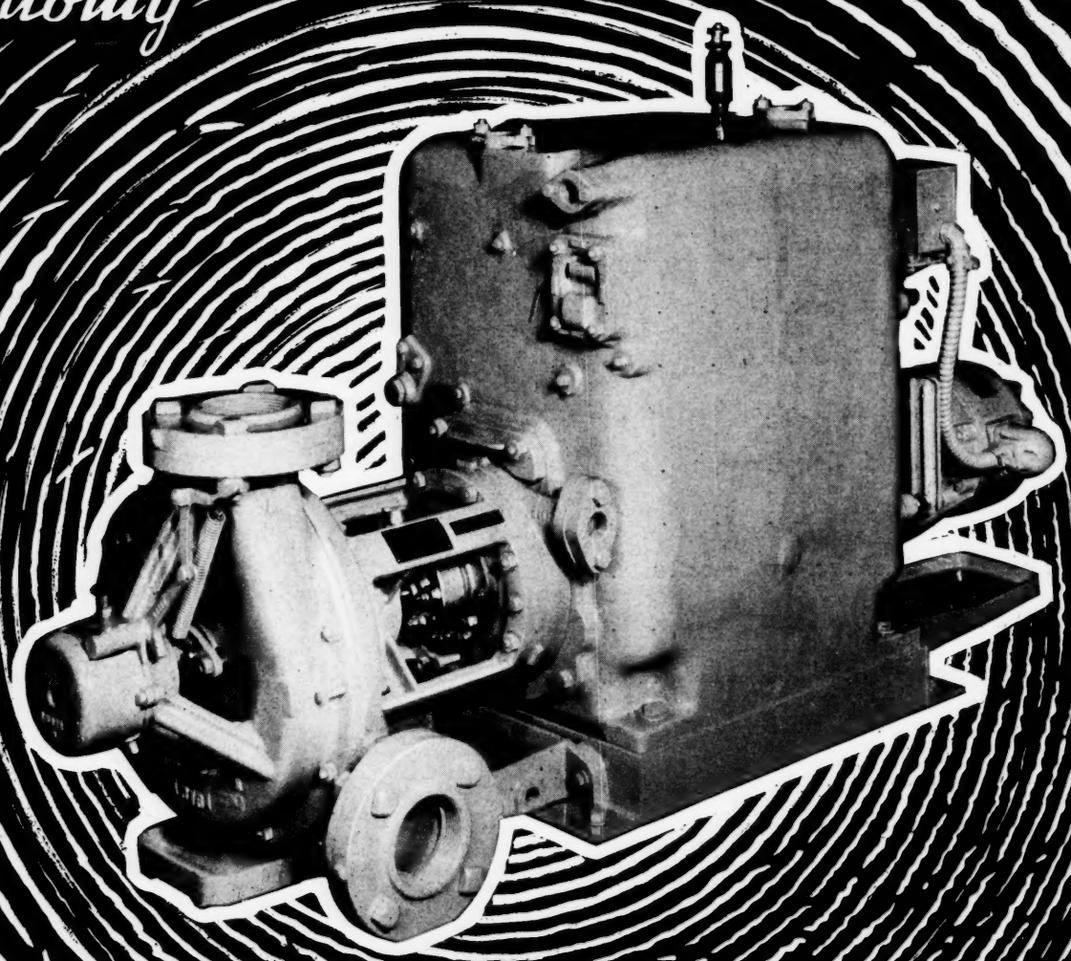
Centralized Heating Economy



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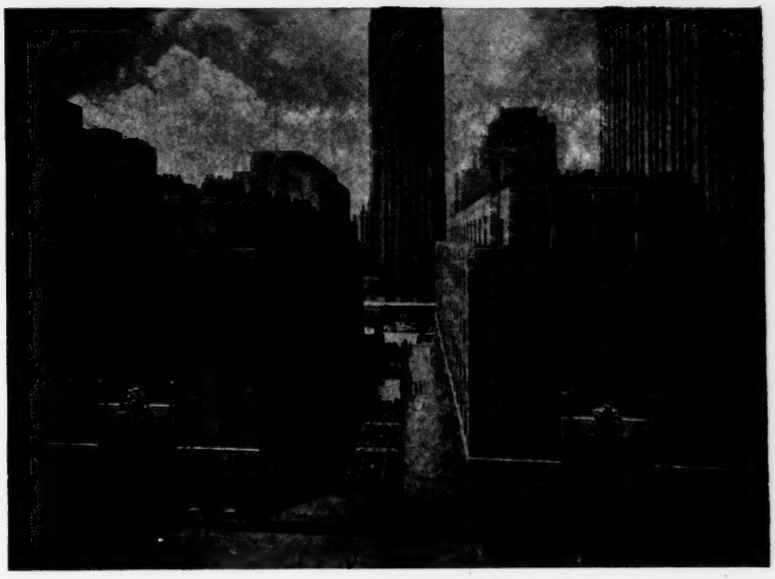
When to Use Steam Jet Units for Air Conditioning†

By M. A. NELSON‡



The French Building, in the left foreground, and the British Building to the right, which flank the entrance to Radio City, New York, are both cooled by steam jet refrigeration.

Recent improvements in steam jet cooling . . . Advantages of steam jets . . . Types of condensers . . . Steam pressure and cooling . . . Water temperatures . . . Operating difficulties . . . Comparison of costs . . . Stage cooling

A VACUUM or steam jet cooling unit operates on the principle that for each temperature a definite pressure exists at which the refrigerant, water, boils. In the cold tank, or evaporator, the pressure is maintained such that the chilled water discharged is at the desired temperature. Enormous volumes of water vapor or low pressure steam are generated and removed by the booster ejector or steam jet compressor. However, because of the high latent heat of evaporation of water, the actual weight of refrigerant evaporated for a ton of refrigeration is less than for any other refrigerant.

A vacuum or steam jet cooling unit is simply a three-stage condensing ejector. The first stage may consist of several ejector elements operating in parallel, or, in the case of stage condensing, practically in parallel. The second and third stages, because of their duty, generally consist of only one ejector element in each stage. Normally inter-stage condensing is employed.

Recent Improvements

The successful operation of vacuum or steam jet cooling units commercially was dependent, not only on the development of several pieces of apparatus making up a complete unit, but also on development of the several sources of power input to the refrigeration unit.

With reference to the improvements in the vacuum or steam jet cooling unit itself, a few of the accomplishments are:

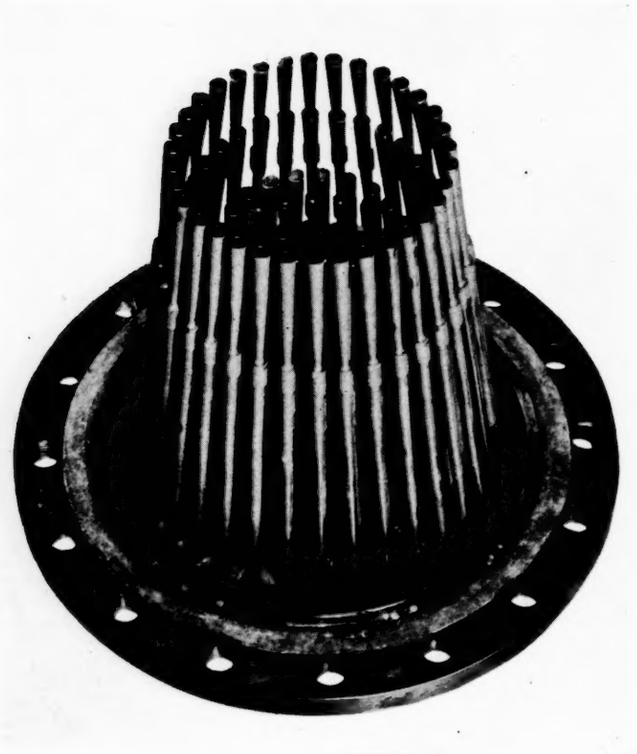
1. The steam jet compressor has been developed so that an approximate improvement in steam consumption of 25% has been realized.
2. Changes in mechanical design, essentially toward simplicity of construction and reduction in number of parts, has greatly reduced the manufacturing cost.
3. The replacement of the secondary air removal equipment, originally designed as a hydraulic or rotating dry vacuum pump, by the steam actuated air ejector, has resulted in materially reducing intitial costs, power requirements, and weight.
4. Condenser design changes have improved the heat transfer rate from approximately 350 to 650 B.t.u. per sq. ft. per °F per hr. These changes in condenser design have resulted in decreasing initial costs, weight, and amount of condensing water through-put.

Types of Condensers

Three types of condensers may be employed, surface. low level jet, and barometric. In the surface type, the steam and vapor are condensed on the outside surface of the tubes carrying the cooling water. Only the condensed steam and vapor must be pumped from the high vacuum space.

†Abstracted from the report of the Research Committee, and presented at the 27th annual convention of the National District Heating Association, June 16-19, 1936.

‡Condenser Engineering Dept., Westinghouse Electric & Mfg. Co., Philadelphia, Pa.



Early LeBlanc steam chest

In the low level jet type, the steam and vapor are condensed by direct contact with the cooling water and both the condensed steam and vapor, and the cooling water must be pumped from the high vacuum space. Initial cost is less but the pumping cost is much greater.

In the barometric condenser, the steam and vapor are condensed by direct contact with the cooling water, but instead of pumping the condensate and cooling water from the condenser, a tail pipe of sufficient length is provided, so that this water is removed by gravity. The initial cost is less and the pumping cost is eliminated, if the cooling water is only to be passed through the unit once and discharged to waste.

Advantages of Steam Jets

Vacuum or steam jet cooling units have certain definite advantages when compared to other kinds of refrigeration. The use of water as a refrigerant is one of the more important. The absence of a toxic or inflammable refrigerant has definite intrinsic value which should be reflected in insurance rates, as high pressures are confined to the motive steam line, and failure of any portion does not release objectionable chemicals within the enclosed space. Water as a refrigerant has the further advantage in that the replacement of refrigerant is an inexpensive operating item since, in many cases, it can be made up from the condensate in the main condenser. Another advantage, from the operating and maintenance standpoint, is that the unit contains no moving parts except centrifugal pumps, which require only occasional lubrication and gland packing, a float valve governing the admission of chilled water to the evaporator, the movement of which is generally very slight and, finally, on those units operating on automatic control, certain steam, vapor, or water valves must be operated by a control circuit.

These units are admirably suited for any location which may be chosen because of convenience for operation. The small weight per unit of floor space permits their installation on the roof or in the upper portion of the building which they serve. Because of this light weight, the individual pieces can be handled easily and erection costs are small. This is an important item when these units are used in conjunction with a cooling tower, for the unit may be located in close proximity to the tower, reducing the initial piping cost and operating cost. There are no vibration difficulties to overcome in mounting, and the noise of operation is slight, which is a further advantage when selecting the site of installation. High partial load efficiencies are obtained at as many points as there are booster ejectors. For example, with six boosters, the efficiency at 1/6, 1/3, ½, 2/3, 5/6, and full load, varies only by the amount of secondary ejector steam, which is an insignificant amount compared to the total steam used by the unit.

In those systems where an open type spray washer is used in series with the vacuum cooler, the smoke and objectionable odors absorbed by the water are given up when passing through the high vacuum maintained in the vacuum cooler. These are then removed from the vacuum cooling unit by means of the secondary ejectors and may be discharged outside of the space conditioned. The water returning to the spray washer has been reactivated and does not become saturated as in other forms of refrigeration units.

Standardization

Vacuum or steam jet cooling units are strictly custom-built refrigeration units. Certain standardization under the four main headings of: motive steam pressure, condenser inlet water temperature, chilled water discharge temperature, and unit tonnage has been accomplished.

This standardization has been attempted by the manufacturers because it reduces the amount of tailor-made apparatus. This is reflected in decreased first cost and cost of renewal parts, because it materially reduces development, the major item of expense in the manufacture of custom built apparatus.

Vacuum or steam jet cooling may be applied wherever it is desired to supply cold water at any temperature above 35F. However, it is not intended to convey the impression that vacuum or steam jet cooling is the only answer to the problem of supplying this source of cold water. With the wide variations possible in the conditions under which the cooling unit will be operated, it is impossible to say, for any specific case, whether a steam jet unit has any advantage over other forms of refrigeration unless a complete study of the case is made.

Steam Pressure

The steam jet compressor, or booster ejector, is fundamentally different in operation from other types of compressors in that as the motive steam pressure decreases, a point is reached at which the booster "breaks" back; that is, the compressor suddenly drops all its load. The chilled water condenses a major por-

tion of the motive steam, with the result that the vacuum cooler becomes a heater. Other forms of refrigeration units would not drop the load but would continue to operate at reduced capacity. For this reason, it is imperative that the steam pressure used when designing the booster ejector be definitely established as the minimum pressure which will exist at the vacuum cooler location, and not the pressure that is normally carried in the steam main or boiler supplying the building.

Much has been said by the manufacturer, and repeated in this discussion, about the importance of the minimum steam pressure for design purposes, because the manufacturer is primarily concerned with a satisfactorily operating unit. However, from the standpoint of the operating engineer, it is equally important to maintain the design steam pressure in order to achieve minimum operating costs.

Another fundamental difference between the operation of a steam jet cooler and other forms of refrigeration, lies in the fact that there is no governor regulating the amount of steam consumed by the unit. The only metering device on the vacuum cooler is the orifice, or the throat diameter of the steam nozzle. The amount of steam passed by this nozzzle varies directly as the absolute pressure of the motive steam. Therefore, as the steam pressure increases above the design pressure, the steam consumption increases proportionately and, due to the fact that the compressor has fixed dimensions, no increase in capacity accompanies this increase in steam consumption. Pressure control, therefore, is essential for economical operation in cases where the steam pressure varies much from the design value.

In order to apply a vacuum or steam jet cooling unit, steam must be available at some pressure above 2 lb. per sq. in. gage. Although on development tests, successful operation has been obtained at pressures as much as 5 lb. below atmosphere, such an application would not be desirable because the steam main itself would be under vacuum, with the attendant difficulty of maintaining an absolutely air-tight line, and because of the excessive size of this header, due to the high specific volume of motive steam. A practical limitation for the operating pressure is about 2 lb. gage. Steam consumption materially decreases with increased pressure up to about 100 lb. gage. For pressures above 100 lb. gage, the gain in steam economy is very slight. The source of steam must, in all cases, be dry and saturated. There is nothing gained in compressor performance by using superheated steam, and there is a material loss in the condenser due to the fact that the condenser must then remove more heat per pound of steam entering, and the heat transfer rate is materially reduced in that portion of the condenser which desuperheats the steam.

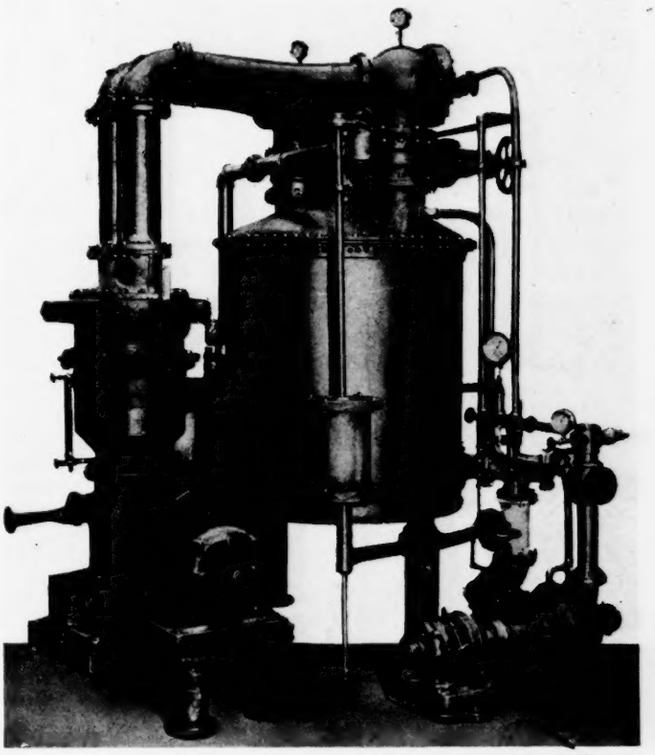
Cooling Water

The other factor of prime importance, the cooling water temperature, is as important in the design as the booster steam pressure. With the booster operating on the design steam pressure and at rated tonnage, a given amount of heat must be dissipated by the cooling water. If the cooling water temperature selected for the design is lower than the maximum that will be encountered, the maximum vacuum that can be maintained in the condenser of the vacuum cooler will be less than the design vacuum. With this reduced vacuum existing in the condenser, the effect on the operation is exactly the same as though the steam pressure dropped below the design pressure.

When using cooling towers, it is not always necessary to design the cooling tower for the worst possible condition of wet bulb temperature known to have existed in the locality in question. Frequently, in order to keep the overall first cost of installation consistent with normal operating conditions, the cooling tower is designed for the normal maximum wet bulb temperature and, on those rare days or hours when this temperature is exceeded, city water is introduced into the condenser circulating system in sufficient quantity to maintain the inlet temperature equal to the normal maximum temperature from the tower. Thus, it is often possible to make material savings in the cooling tower first cost, which more than balance the additional operating cost for city water.

In many cases the discharge water from the condenser of the vacuum cooling unit is not discharged to waste, but is used for building service—such as in a laundry. In case it is expected that there will be building or process users of this water after use in the condenser, it is essential that the manufacturer be informed what maximum discharge water temperature can be used.

Since the motive steam, as well as the vapor removed from the refrigerant must be condensed, more cooling water is required for this type of unit than for any other kind of refrigeration equipment. This means that a larger cooling tower and larger piping between



Unit installed at Union Switch and Signal Co., 1916

the cooling tower and the condenser are required, which constitute the chief disadvantages or limitations in the application of vacuum or steam jet cooling units.

Cooling water for the condenser is often taken from the city water mains for both vacuum coolers and other forms of refrigeration. Continuation of this practice will impose a burden on the city water supply in the summer, which undoubtedly will result in the passing of ordinances prohibiting the diversion of the public water supply for this purpose. Thus, cooling towers will have to be used as a means of providing the cooling water for air conditioning applications. It is usually more economical to use cooling towers even though the use of city water for this purpose is not prohibited.

Operating Difficulties

There has been considerable criticism of this form of refrigeration unit because of the large water requirement of the condenser. It will usually be noted in these cases that if the units were used as originally designed, the water consumption would not be greater than that guaranteed by the manufacturer. If, however, the manufacturer has been misinformed as to the maximum discharge water temperature permissible and the unit is so operated that this water temperature is lower, the increase in water consumption over that guaranteed is not the responsibility of the manufacturer. Again, should the inlet water temperature exceed that given to the manufacturer for his condenser design, resulting in the inability of the vacuum cooler to maintain full load due to decreased condenser vacuum, the responsibility is not the manufacturer's.

It is sometimes possible to overcome the hand'cap of excessive condenser water inlet temperature by increasing the amount of water circulated through the condenser when sufficient water can be circulated, so that the discharge water temperature is no higher than would be expected with normal inlet water temperature.

Other operating difficulties which sometimes arise are listed as follows:

1. Low Vacuum: This may be attributed to

(a) The development of an air leak in the high vacuum equipment.

(b) Failure of the loop seal or trap between the inter-condenser and the main condenser, resulting in the short-circuiting of air from the inter-condenser to the main condenser; corrected by refilling the loop seal.

(c) Foreign material being lodged in the throat of the steam nozzle on one or both stages of the secondary ejectors.

(d) Failure of the cooling water supplying the secondary condenser, which would be detected by a considerable steam discharge from the air vent of the after condenser.

(e) Failure of the condensate pump to remove the accumulated condensate in the main condenser, for instance, valve in the vent line being closed.

(f) Wet steam supplied to the ejectors. For instance, the steam may be taken from the bottom of the main header or this line has a low point in which water may collect. These ejectors will not operate on wet steam.

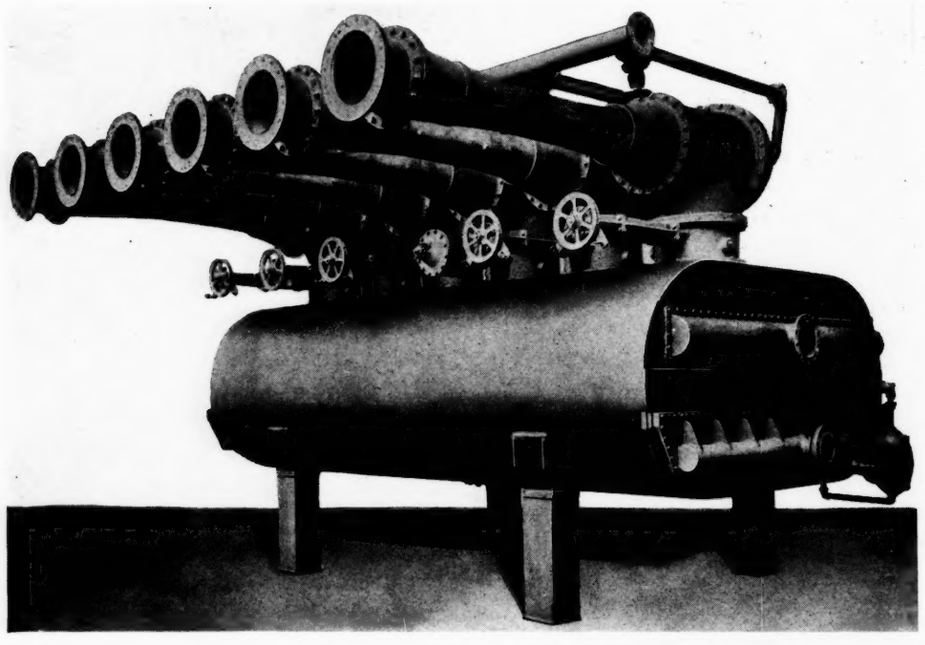
2. Unstableness of Booster Ejectors: In practically all cases, failure of booster ejector to start, with other conditions satisfactory, can be attributed to foreign material lodged in the throats of the steam nozzles. Occasionally failure is due to low steam pressure at the nozzles because a valve disc has wedged only partially off its seat or the steam line is partially plugged with foreign material.

Cost

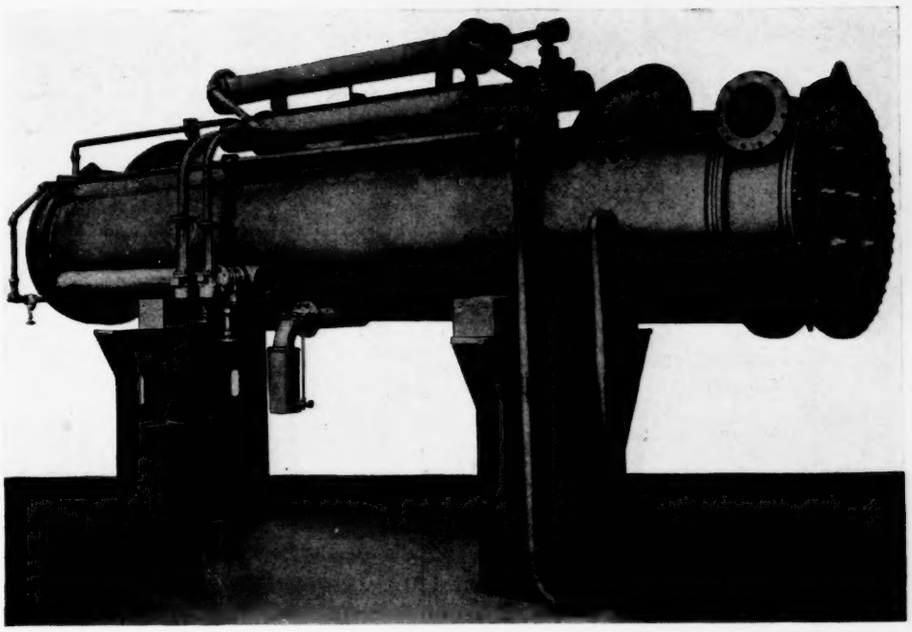
In general, the initial cost of a steam jet unit, as compared to other forms of refrigeration, is less for sizes above 75 tons. This does not mean, however, that for sizes less than 75 tons there is no application for this type of refrigeration. Where local conditions were such as to justify the increased first cost, because of marked operating savings, there have been many applications for vacuum coolers or steam jet refrigeration units in sizes less than 75 tons.

Previously mention was made of the number of variables affecting the design of this class of apparatus. In order that the manufacturer may quote intelligently on apparatus, there are a number of questions which must be answered. Every manufacturer has some form of questionnaire which he has devised and included in his general bulletin for circulation. Certain other data not generally included in these questionnaires, but of prime importance, are:

1. The manner in which the first cost and carrying charges are to be absorbed.



Evaporator and compressors of 600-ton unit.



Condenser and secondary ejectors for 600-ton unit.

2. The economic value, in dollars and cents, of the motive steam, the water used for condensing purposes, and the electric power used for driving the several pumps. For example, with expensive steam and cheap water, it is possible to decrease the operating cost by greatly increasing the amount of circulating water and decreasing the amount of steam used. If, on the other hand, water is relatively more expensive than steam, it is obviously desirable to use more steam and less water.

The standard steam jet cooler is designed so that the suction pressure and discharge pressure for each booster ejector is the same; that is, in the flash tank a uniform pressure exists and all boosters discharge into a common condenser. Such a design does not achieve maximum economy but provides a unit which, for the average application, nicely balances first cost and operation expense.

Stage Cooling

For those cases where economy of operation can be justified over increased first cost, two principles, fundamentally similar, but different in application, may be employed. That is, the compression ratio on the several compressors is designed for different values, and is not maintained constant as it is on the standard unit. This can be accomplished: first, by stage cooling; in this case the water is cooled in several steps, the compressors are all discharged into a common condenser and the compression ratio on these compressors is varied by operating at different suction pressures; second, by stage condensing, in this case the compressors are discharged into separate compartments in the condenser or into separate condensers and the condensing water is passed through the several compartments or condensers in series, resulting in the maintenance of different vacua in them, the compression ratio on the compressors being varied by operating at different discharge pressures; and third, by combining these two, providing a unit in which stage cooling and stage condensing both were employed.

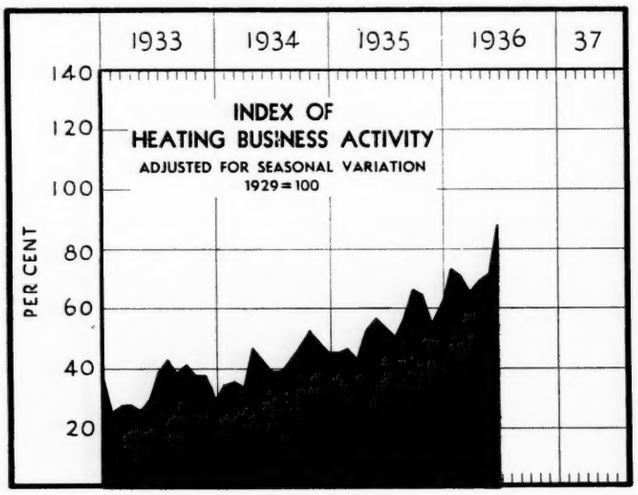
Stage cooling, which is the least expensive from the standpoint of first cost, would only be employed in those cases where a large cooling range may be encountered. It is not applicable to the usual cooling range of about 6F normally encountered, because the economies realized are not sufficient to warrant the added expense. Stage condensing, which is the more expensive of the two possibilities, may be used on applications having the normal cooling range. Theoretically, the number of stages of condensing is limited by the number of booster ejectors employed. Practically, the extent to which stage condensing will be employed is limited by the temperature rise of the cooling water when passing through the condenser. More than three stages condensing is the exception; practically all applications falling in three or less stages of condensing. Further stage cooling or condensing will not normally be applied on units of small size. The added cost can only be justified on units of medium or large size.

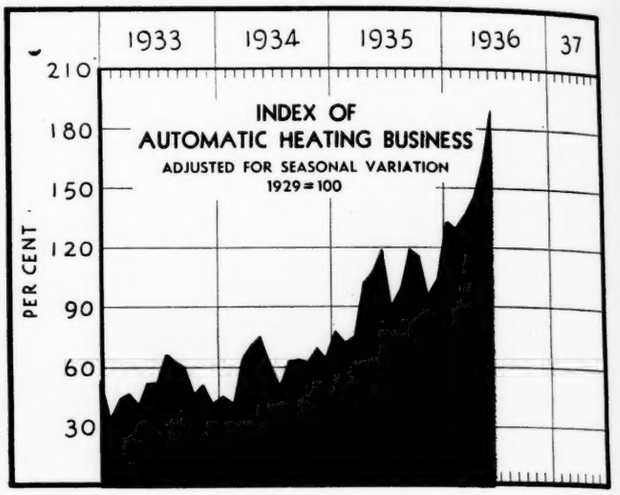
Effect of Load

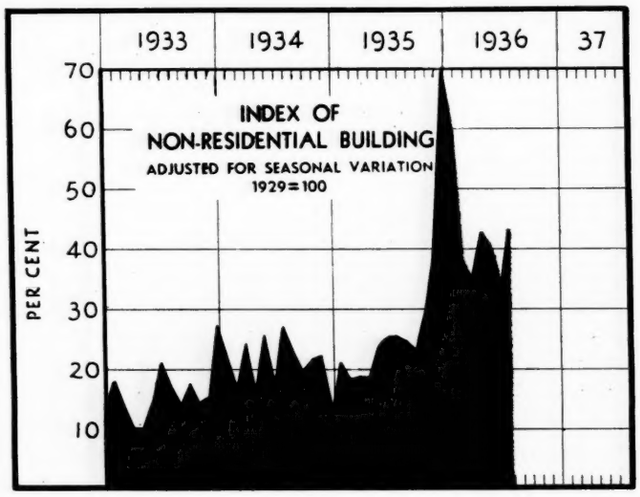
All design data are based on the maximum operating conditions and the assumption that the maximum load and maximum cooling water temperature occur at the same time. This condition prevails for only a short period of time during the season's operation. The remainder of the time the unit will be operated on partial load and lower cooling water temperatures. Economies of operation may be employed to take advantage of both partial load and colder water. These economies may be effected in either steam consumption or the quantity of water circulated to the condenser, depending on which has the greater value economically. In the case of the cooling tower application, without doubt the cost of steam is the more important item. Under these conditions, full cooling water will be continuously circulated through the condenser and the steam pressure operating the booster ejectors can be reduced in accordance with a curve showing the relation between condenser vacuum and steam pressure, which is normally supplied as operating material to the purchaser by the manufacturer.

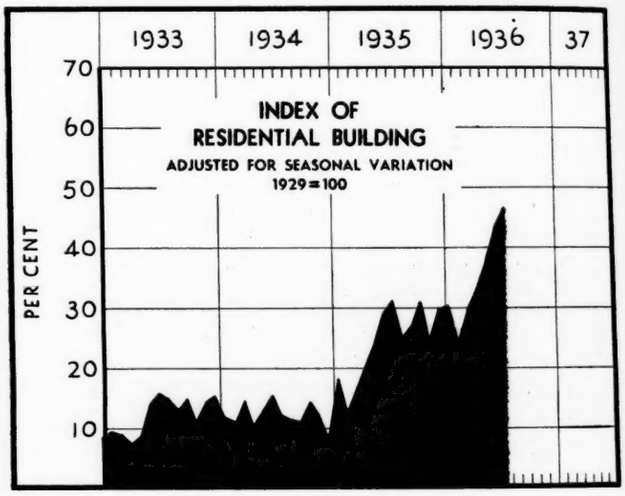
If, on the other hand, city water is being used as the cooling medium for the condenser, the cost of cooling water will be the predominant factor. The quantity of cooling water may be diminished so that the discharge temperature of this water leaving the condenser will be approximately the same as the design temperature. Both the steam pressure and the water quantity may be thermostatically or automatically regulated.

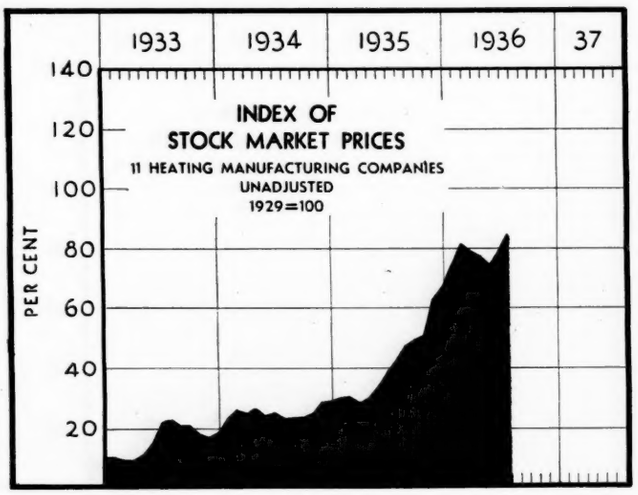
HEATING BUSINESS TRENDS

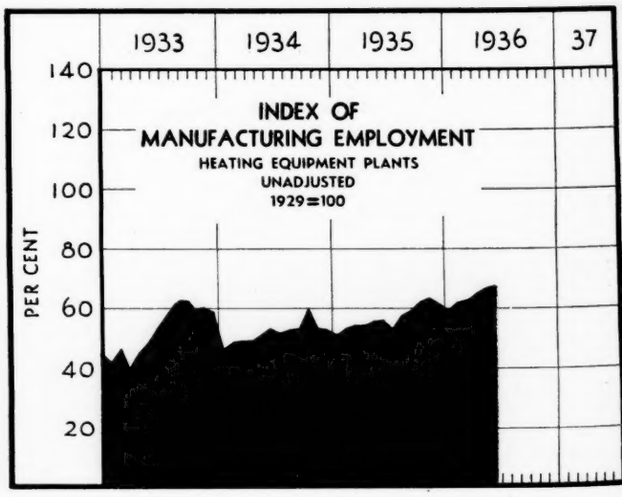












Heating Index Reflects Best Business Since 1929; Jobbers Report 60.7% Gain

BUILDING contracts during July increased approximately 10% from the preceding month. After adjustment for seasonal variation the building contract index stood at 45% of 1929 levels as compared with 28% for July, 1935, and 37% for June, 1936. The greatest increase was in non-residential building which rose from $79 million in June, 1936, to $96 million in July.

HEATING & VENTILATING'S Index of Heating Business increased in June to 90.5, the highest point since 1929. This compares with 72.9 for May and with 55.4 for June, 1935. The Index of Automatic Heating also reached a new all-time high, 189.9 for June, as compared with 165.8 for May and with 121.5 for June, 1935. The figures are in percentages of 1929 but it should be noted that they refer to the physical volume of business and not to the dollar volume. In other words, the number of boilers, radiators, oil burners, etc., being installed compare with the number installed in 1929 in proportion to the heating index, but the dollar volume of heating contracts actually is still below 1929 levels.

All equipment sales increased in June from May as the peak season approaches. Sharp increases were reported in oil burners, oil burner-boiler units, and furnace-burner units, with the total number of oil-burning devices sold having an increase from 8,777 in June, 1935, to 13,175 in June of this year. High increases were reported in both small housed blowers and propeller fans. Almost a million and a quarter dollars worth of unit air conditioners were shipped during June, with the self-contained units running about two-thirds as much as remote type units. Central air conditioning systems for comfort totaled over one-half million dollars while industrial air conditioning systems of the steel type amounted to less than $25,000. All other refrigerating equipment sold to contractors or other distributing outlets (not including manufacturers) for air conditioning totaled somewhat over a third of a million. Sales of air filters during June were the smallest of the year and amounted to only $12,430. Sales of unit heaters increased from May and totaled nearly $300,000, while the figure for unit ventilators fell off markedly from June.

A noticeable feature of the June shipments was in convectors. Nonferrous convector sales amounted to over a million square feet and cast iron convectors totaled over six hundred thousand square feet, both showing extremely large gains over the corresponding figures for 1935. Steel boiler sales during June were slightly less than double those of a year ago while residential stokers were almost double those of last year. Round cast iron boilers showed a small gain from the 1934 figures while square cast iron boilers were nearly double those of a year ago. Cast iron radiators also increased sharply.

The Commonwealth Edison Company of Chicago reports 112 air conditioning installations in that city during July as compared with 68 in June. The July installations totaled 644¾ tons as compared with 697 tons during June, indicating a multiplicity of small jobs. The classification of these installations is important in that it shows a marked increase in the number of residences having air conditioning. Of the 112 installations, 29 were in residences, averaging about ¾ of a ton but ranging from ½ to 3 tons in capacity. Of the remainder, three were in barber shops, three in industrial establishments, 16 in general offices, 34 in private offices, four in restaurants, 14 in stores, two in undertaking establishments, and one in a theater. The largest installation during the month was an 85-ton addition to a candy factory installation, followed by

(Concluded on page 78)

HEATING AND AIR CONDITIONING BUSINESS TRENDS

INDEXES (1929 = 100) (Seasonally Adjusted)	June, 1936	June, 1935
HEATING & VENTILATING'S Index of Heating Business	90.5	55.4
HEATING & VENTILATING'S Index of Automatic Heating	189.9	121.5
HEATING & VENTILATING'S Index of Contractor Activity	71.4	37.8
INDEXES (1929 = 100) (Seasonally Adjusted)	**July, 1936**	**July, 1935**
HEATING & VENTILATING'S Index of New Building	45.0	28.0
HEATING & VENTILATING'S Index of Stock Prices (Unadjusted)	85.6	43.8
EQUIPMENT SALES	**June, 1936**	**June, 1935**
Mechanical draft oil burners, number of units	11,185	7,783
Oil burner-boiler units, number	1,411	837
Oil burner-furnace units, number	541	137
Blowers for public buildings, dollars	135,831	111,716
Small housed blowers, dollars	149,068	48,872
Propeller fans, dollars	395,053	165,114
Unit air conditioners, self-contained, dollars	479,685	—
Unit air conditioners, other, dollars	763,884	—
Central air conditioning systems, comfort, dollars	536,745	—
Central air conditioning systems, industrial, dollars	23,430	—
Refrigerating medium for air conditioning, dollars	350,079	—
Air filters, dollars	12,430	—
Humidifiers, dollars	82,323	—
Air washers, dollars	87,970	—
Unit heaters, dollars	298,643	192,731
Unit ventilators, dollars	168,572	187,129
Cast iron radiators, thousand sq. ft.	5,590	3,462
Steel boilers, number	639	323
Stokers, class one, number	4,381	2,432
Stokers, class two, number	199	158
Stokers, class three, number	76	55
Indirect heating surface, non-ferrous, dollars	151,195	102,598
Indirect heating surface, cast-iron, dollars	7,107	10,968
Non-ferrous convectors, sq. ft.	1,045,868	449,724
Cast iron convectors, sq. ft.	612,618	245,830
Round boilers, thousand pounds	3,193	2,710
Square boilers, thousand pounds	19,523	10,700

Degree-Days Page Mr. Consumer

By W. L. JONES†

This paper won third prize in HEATING & VENTILATING's recent DEGREE-DAY COMPETITION. It illustrates how one firm sells the degree-day idea to its customers in order to explain high winter bills to them.

ENGINEERS familiar with heating calculations know that Degree-Days have been working for them for many years. It was more than ten years ago that this unit of measure was founded and since that time it has become widely accepted in practically all branches of the heating industry. Within the industry some would make changes in the unit and others suggest changes in the method of application but for the most part the Degree-Day unit serves its purpose and has done much to reduce the heating man's worry.

But have Degree-Days really been put to work? Ask the man on the street if he ever heard of one. When he has a home to heat he is vitally concerned. He will daily discuss how cold it is, how much fuel he is using, and similar related subjects. It is Mr. Consumer and not the engineer that today needs to know about Degree-Days.

Quick,—how soon can you give the answer to this problem? If the average daily temperature was 60F every day during September and 45 degrees every day during November, how much colder, on a percentage basis, was November than September?

To most people the answer to this problem is obvious . . . November was 25% colder. But 25% is wrong. To the heating man who knows how to compare Degree-Days, November was 300% colder . . . 600 Degree-Days as compared with 150.

But how can these matters be brought to public attention? Is Mr. Consumer interested? The answer can be well illustrated by one case wherein the public was let in on the secret of Degree-Days to the mutual advantage of all concerned. In 1932 The St. Louis County Gas Company made a large reduction in its gas heating rates and gave wide publicity to this fact. Several hundred heating customers were given definite information concerning the extent of the reduction and large numbers of new customers were given definite information concerning probable heating costs—assuming that the coming winter would be normal.

Of course, no assurance could be given that the weather would be normal and so, before the winter set in, definite steps were taken to acquaint users with the heating term Degree-Days and its relationship to heating costs. If this could be done and the winter did vary materially from normal, customers would have a basis for understanding the variation.

First, arrangements were made with the United States Weather Bureau whereby temperature data were obtained daily. Following this, arrangements were made for each bill for gas heating service to show clearly, in a space provided for the purpose, the number of Degree-Days for the period covered by the bill. When these arrangements were completed a letter was sent to all heating customers explaining the Degree-Day unit and calling attention to the fact that the information would appear on their monthly bills for service.

Many of the customers who received this original letter have never actually learned the definition of a Degree-Day and it must be admitted that many who received the letter paid but little attention to it. However, from time to time other information on the same subject followed and the repeated entry of the Degree-Day information on monthly bills has kept the matter constantly before these people. During each winter various publicity measures have been used and today most gas heating customers know that the unit of measure of cold weather, in terms of heating requirements, is the Degree-Day. They do not know its technical definition, any more than they know the technical definition of an inch, but they do know that cold weather is measured in Degree-Days and that the gas company has up-to-date information on this subject.

Today in this community it makes little difference whether winters are normal or abnormal as long as heating cost variations show a reasonably constant relationship to Degree-Day variations. The winter of 1935-36 was 18% colder than normal and 24% colder than the preceding winter and yet, to people who heated with gas, the increase in fuel consumption was not shrouded by mystery and misunderstanding. These

(Concluded on page 78)

†The St. Louis County Gas Co., Webster Groves, Mo.

THE ST. LOUIS COUNTY GAS COMPANY
231 WEST LOCKWOOD AVENUE
WEBSTER GROVES, MO.

SPACE HEATING SERVICE

NOTICE TO OUR CUSTOMERS
The gross and net amount of this bill includes 1% Missouri Sales Tax.

DEGREE DAYS BY CALENDAR MONTHS

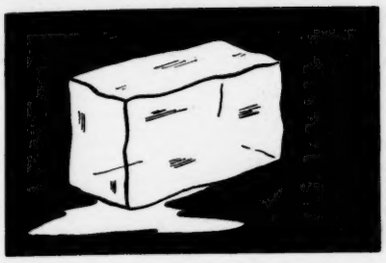
	1929 1930	1930 1931	1931 1932	1932 1933	1933 1934	1934 1935	1935 1936	Normal
September	51	5	16	23	1	60	38	....
October	210	300	144	254	252	114	237	192
November	706	529	322	720	576	443	649	588
December	853	902	617	955	772	983	1076	933
January	1247	843	781	665	842	955	1229	1051
February	553	653	593	839	941	739	....	846
March	639	755	808	629	752	436	....	648
April	196	270	234	300	266	397	....	267
May	54	155	42	68	24	162	....	....
Total	4509	4412	3557	4453	4426	4289	....	4525

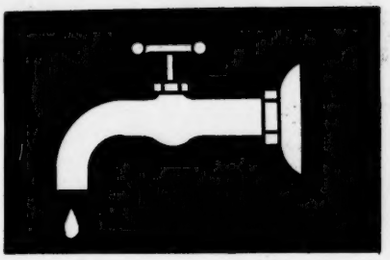
The winter, September to January inclusive, was 16% colder than normal and 26% colder than last winter.

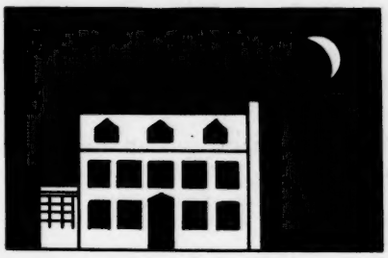
DEGREE DAYS THIS PERIOD	1256
READING 2/27	4560
READING 1/29	4072
HUNDRED CUBIC FEET USED	488
GROSS BILL	30.00
Discount if paid by MAR 13 '36	1.32
NET BILL	28.68
GAS SERVICE	
GAS SERVICE	
TOTAL BILL	

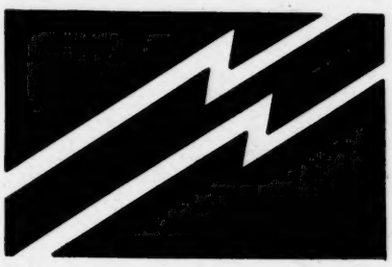
The degree-days for the period covered by the bill are stamped on the bill. Note the table of degree-days for recent months for the cities served by the utility.

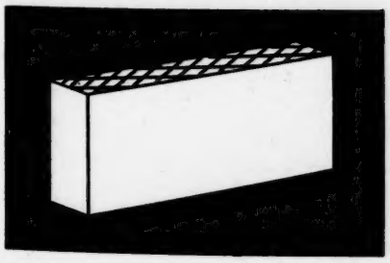
FIVE METHODS OF COOLING A RESIDENCE











A resume of research work in summer cooling and summer air conditioning carried on in the Research Residence at the University of Illinois under the direction of Prof. A. P. Kratz. This investigation, started in 1932, consisted of studies of the use of ice, mechanical refrigeration, city water, and outdoor air at night as the cooling media. Studies of these different methods accompanied by the wide variation in weather experienced during the past four heating seasons, have resulted in the accumulation of a large amount of data which were ably condensed by Prof. M. K. Fahnestock, research assistant, department of mechanical engineering, University of Illinois, in a paper presented at the midyear convention of the National Warm Air Heating & Air Conditioning Association. Material on the seven following pages has been rearranged from Professor Fahnestock's paper.

ICE . . . . . page 37
WATER . . . . . page 38
NIGHT AIR . . . . . page 39
ELECTRICITY . . . . . page 40
UNIT COOLERS . . . . page 41
COSTS . . . . . page 42

Five Methods of Cooling a Residence

THE HOUSE, WITH ITS HEATING PLANT, WHERE THE FIVE METHODS WERE TESTED

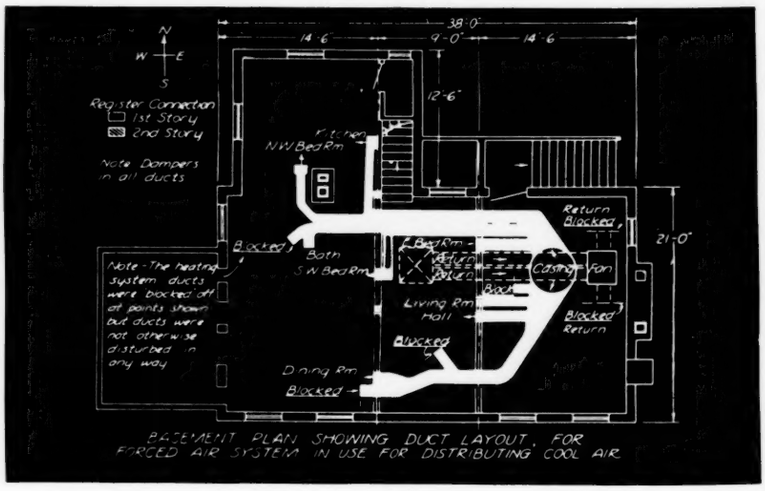
Research residence at the University of Illinois, Urbana.

THE RESEARCH RESIDENCE

Frame construction. Three stories. Wall of bevel siding, building paper, sheathing, studding, wood lath and plaster. Copper shingled roof. No insulation in walls. No weather-stripping, no double glazing, no storm windows. Equipped with awnings on east, south, and west windows. During cooling studies third story was considered as an attic space and closed off by door at top of stairs. Likewise, on first floor, sun-room was isolated. Total space cooled, 14,170 cu. ft. of which 7,300 cu. ft. were on the first floor. Design load for the space cooled, 37,500 B.t.u. per hr., at a design temperature of 91F and with an inside temperature of 80F. Average occupancy about four persons. No heat from cooking in the house.

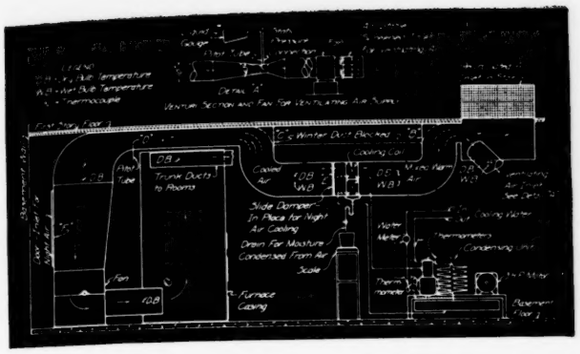
THE DUCT SYSTEM

Basement plan and forced air heating plant shown below. With a few minor changes this duct system was used for distributing cool air for the cooling studies. All return ducts, with the exception of one from foot of stairs on first floor, are blocked. Delivery ducts to first floor and sun-room were blocked by dampers. Air velocities in the ducts did not exceed 750 f.p.m., and in most cases were below that. Room air introduced into rooms through common type of baseboard register except in one case where a wall type register 7 ft. above the floor was used.



Arrangement of the ducts in the basement of the research residence designed for forced air heating system and used for distributing cooled air in the summer.

COOLING WITH ICE



TEST PLANT

In general, arrangement of plant similar to that shown above, except that instead of condensing unit shown plant included insulated bunker or tank with two-tons ice capacity. Chilled water pumped from bottom of tank to cooling coil (six rows deep). Sprav heads spray water returning over the ice. Winter return duct was not tightly blocked in B and C as shown in drawing referred to, but instead a modulating bypass damper was located at B and the damper at C was omitted. Whenever cooling was needed a constant quantity of cold water was circulated through coil, thermostat operating the bypass damper varying the quantity of return air passing through cooling coil. Fan delivered 1,475 c.f.m. of air, or 6.2 air recirculations per hour. No ventilating air or night air was used. Awnings on east, south, and west windows in most but not all tests.

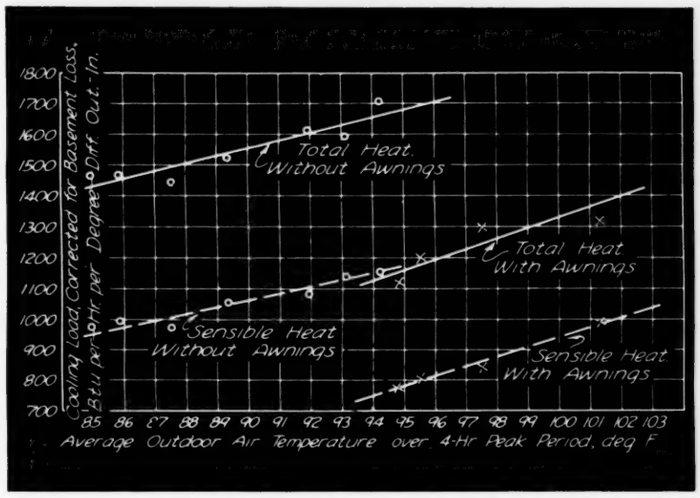
TEST PROCEDURE

All of the windows, including those in the attic, remained closed continuously day and night, and cooling plant was started when effective temperature indoors rose to 75F irrespective of outdoor temperature. This usually occurred when indoor dry bulb temperature reached between 78 and 82F, depending on relative humidity. After starting plant, indoor dry bulb temperature remained practically constant within a range from 78 to 80F, but due to reduction in moisture in air, indoor effective temperature usually was lowered to about 72F. Operation of plant was continued until outdoor dry bulb temperature was several degrees below that indoors.

Chilled water entered cooling coil at about 35F. About 396 g.p.h. was circulated. Average temperature of water in coil was about 39F. Under these conditions temperature of air at inlet registers to rooms did not fall below 60F. Cooling load on residence over any interval of time was determined by amount of ice melted. No air, other than that which leaked in by natural infiltration, was provided for ventilation or cooling at night.

RESULTS

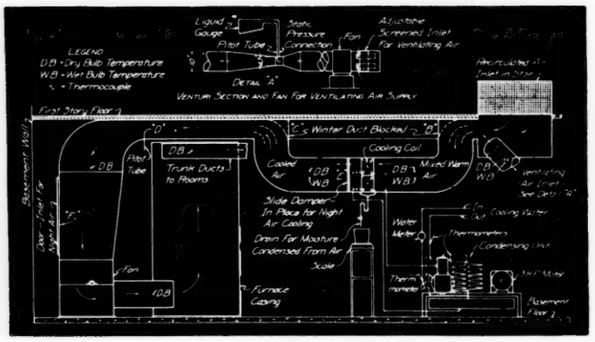
Results indicated that with minor adjustments central forced air heating system can be successfully used to distribute cooled air in summer. When duct dampers were adjusted to balance cooling load the house was uniformly cooled irrespective of the position of the sun or change in the cooling load. The modulating damper actuated by the single thermostat in the dining room which proportioned the amount of return air passing through the cooling coil in accordance with the cooling load, gave excellent regulation of the indoor air temperature. Cool air was delivered from registers at temperatures from 60F to 70F and at velocities from 50 to 450 f.p.m., and, although cooled air was delivered to all rooms but one through baseboard registers, average temperature difference between floor and ceiling was only 3.5F. An objectionable draft was noticeable in one room but a baffle in front of the register to direct the air toward the ceiling corrected this. Average rise in temperature of air from fan inlet to register faces was about 3F. Although no insulation was used on duct surfaces except around the cooling coil no condensation appeared on the ducts or furnace casings. Chilled water temperature being below dewpoint of air entering coil, considerable dehumidification took place, reducing indoor relative humidity to about 45% after plant got under way. Average dry bulb temperature after several hours of operation was usually about 78F, slightly cooler than necessary for average residence. Drawing below shows reduction in cooling load due to use of awnings based on averages of data from four hottest hours of the day. Reduction in load by awnings was about 30%. Objectionable odors were noticeable on many days, since house was closed day and night with no ventilating air.



Reduction of load during hottest hours of day due to use of awnings.

COOLING WITH

WATER



TEST PLANT

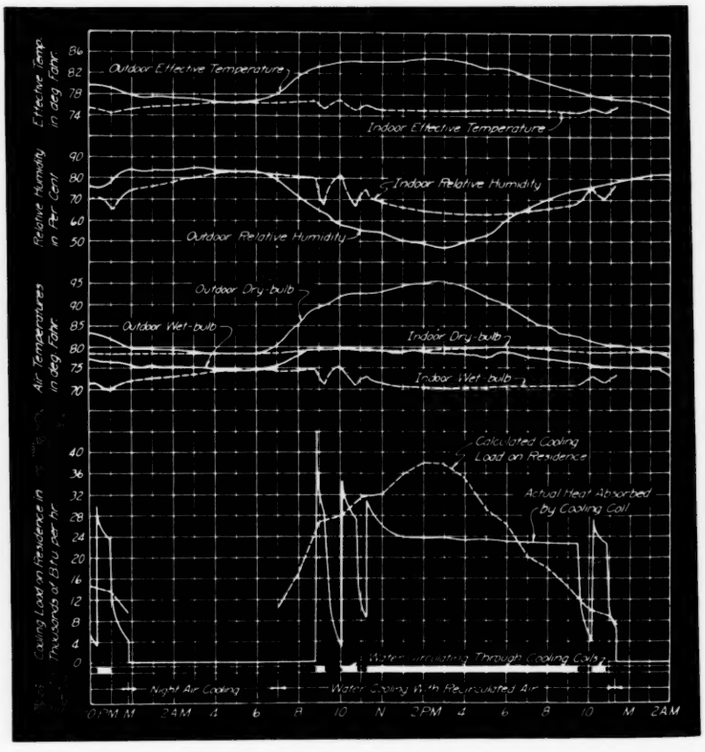
Arrangement generally same as that shown above. Cooling coil has eight rows of fin tubes in bypass in central return duct. Duct was tightly blocked at B and C as shown, and all of air delivered to fan passed through coil when plant was operated. Water from city service main at 58F was controlled by motor-driven valve, in turn controlled by thermostat. Water consumption rate was 360 gal. per hr. Use of deeper coil than that required for previous tests made necessary larger fan to maintain air delivery of 1,300 c.f.m. Fan motor, ¾ hp. Outdoor air, one air change per hour. Arrangement for cooling with outdoor air at night practically the same as that for mechanical refrigeration.

TEST PROCEDURE

Windows in attic opened during day and night. Windows on first floor closed. All tests with cooling by water supplemented by outdoor air circulation at night. Upper windows closed at 7 a.m. and fan which has been delivering outdoor air started delivering ventilation air and recirculated air. The 1,300 c.f.m. delivered was equivalent to 5.5 air changes per hour, of which one air change was ventilating air. Thermostat was set for 80F. and cooling plant operated to maintain that until effective temperature outdoors reached a value equal to the effective temperature indoors. Water valve was then closed, upper windows and basement doors opened, and outside air delivered through to the house at 9.7 air changes per hour.

RESULTS

Operating characteristics and loads shown in drawing below. At 7 a.m., following a period of cooling with outdoor air, the second-story windows and attic doors were closed, and the duct system changed over to indoor air and ventilating air circulation. At 8:50 a.m. the temperature on the second story had risen to 80F, and the thermostat acted to open the motor valve on the outlet water line from the cooling coil permitting water to flow through it. This comparatively simple automatic operation of opening and closing the water supply valve afforded complete and satisfactory control of the cooling plant. From 11:15 a.m. to 9:25 p.m. the plant operated continuously at full capacity, and at 11:20 p.m., following a short period of intermittent operation, the plant was shut down, the windows were opened, and the circulation of outdoor air was started. On this particular day outdoor temperature reached a maximum of 96F at 2:30 p.m. From about 11:00 a.m. to 6:30 p.m. calculated load exceeded actual load, while from 6:30 p.m. to 9:25 p.m. calculated load was less than actual load. Maximum calculated load of about 37,500 B.t.u. per hr. occurred between 2 and 3 p.m., and actual load at this time was about 24,000 B.t.u. per hr. which, under normal operating conditions, was approximate capacity of plant. Results indicated that on days when outdoor temperature exceeded 90F, major portion of day, and cooling plant operated continuously, effective temperature of 75F could be maintained with water. This cannot be regarded as an optimum condition for comfort, but is a material improvement over that which would have existed without cooling. Limitation of plant using water at 50F was inability to maintain reasonably low relative humidities. Although some moisture was removed from air minimum relative humidity of 63% obtained was high in comparison with 45% obtained with ice and mechanical refrigeration. Pressure loss in line between city main and cooling coil was very large and in some installations it might be a limiting factor in determining amount of water that could be circulated through coil.


Effective Temp. in deg Fahr.
Outdoor Effective Temperature
Indoor Effective Temperature
Relative Humidity in Per Cent
Indoor Relative Humidity
Outdoor Relative Humidity
Air Temperatures in deg Fahr.
Outdoor Dry-bulb
Outdoor Wet-bulb
Indoor Dry-bulb
Indoor Wet-bulb
Cooling Load on Residence in Thousands of B.T.U. per Hr.
Calculated Cooling Load on Residence
Actual Heat Absorbed by Cooling Coil
Water Circulating Through Cooling Coils
Night Air Cooling
Water Cooling With Recirculated Air
0 PM M 2 AM 4 6 8 10 N 2 PM 4 6 8 10 M 2 AM

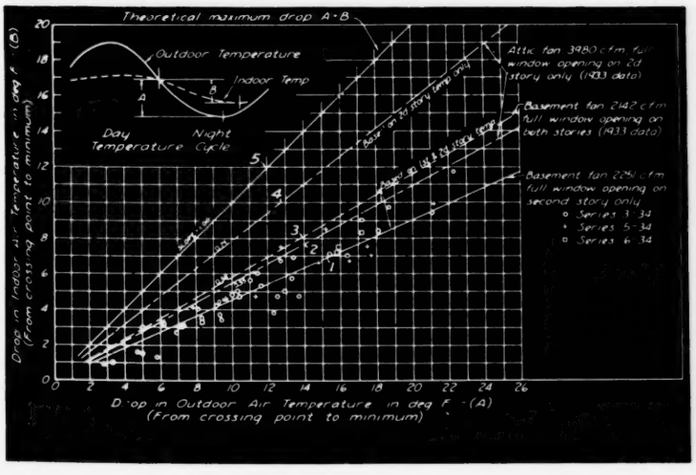
Actual and calculated cooling load on residence and air temperatures for a particular day when using city water for cooling following a period of cooling with outdoor air at night.

TEST PLANT

In addition to the facilities provided for cooling with outdoor air at night by means of the fan in the main air circulating system, during one cooling season an attic fan, shown at the right, was installed in the doorway at the head of the stairs leading from the second to the third story. This 24-in. propeller type of fan delivered air from the first and second stories into the third story or attic space from where it escaped through the windows on all sides. Use of a special duct and damper arrangement on the suction side of the fan, as shown, permitted outdoor air to be drawn into the open first- and second-story windows at night, or to be drawn through a duct from a third-story window in order to provide positive ventilation for the third story during the day. Under both arrangements the fan delivered approximately 4,000 c.f.m. of air, which in terms of the space on the first and second stories was equivalent to approximately 17 air changes per hour. Based on the space on the second story the delivery was equivalent to about 34 air changes per hour.

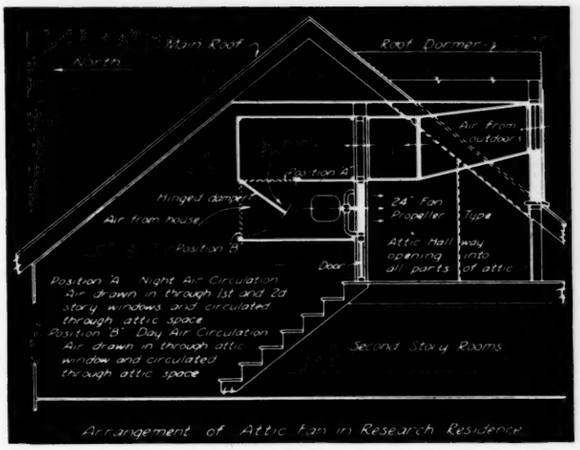
TEST PROCEDURE

Two types of test, circulation of outdoor air at night with (A) an attic fan and (B) with a basement fan. (A) Attic windows open, first-story windows closed at all times. At 6 p.m., second-story windows open and damper at fan inlet placed in position A and fan started, delivering air from first and second stories to attic, then discharged to outdoors. Fan ran until 6 a.m. the following morning when inlet damper was placed in position B, second-story windows closed. House closed all day, no attempt to control indoor temperature. (B) Two series of tests with basement fans were run. In one, windows were fully opened only on the second story, while in other they were open on both first and second stories. Attic windows were opened at all times. In both at 6 p.m., basement door, attic door, and windows were opened and fans started delivering 9.3 air changes per hour. At 6 a.m. the windows and doors were closed and fans stopped. Indoor temperatures were not controlled.


Theoretical maximum drop A-B
Outdoor Temperature
Indoor Temp
Day
Night
Temperature Cycle
Attic fan 3980 c.f.m. full window opening on 2d story only (1933 data)
Basement fan 2142 c.f.m. full window opening on both stories (1933 data)
Basement fan 2284 c.f.m. full window opening on second story only
Series 3-34
Series 5-34
Series 6-34
Drop in Outdoor Air Temperature in deg F. (A)
(From crossing point to minimum)

Graph 1 (Above). Maximum possible effectiveness of using night air is shown in Curve 5 and compared with this are the results obtained by different methods, most practical of which seem to be Curves 1 and 2. Graph 2 (Right). Slope of the line, from Graph 1, is plotted against number of air changes per hour, showing that effective cooling cannot be accomplished with less than 10 air changes per hour and that more than 30 per hour increases the effectiveness but little.

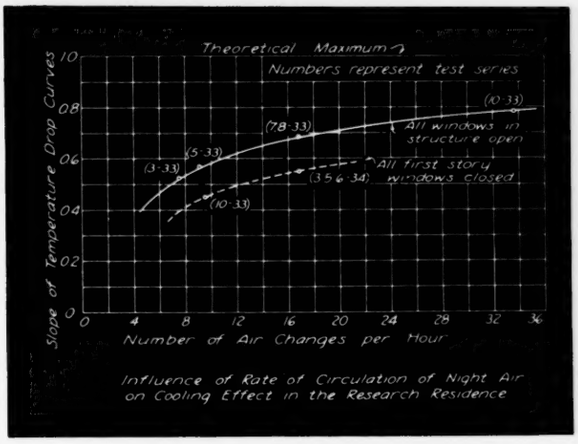
COOLING WITH NIGHT AIR


Main Roof
Roof Dormer
North
Air from outdoors
Position A
Hinged damper
Air from house
Position B
24" Fan
Propeller Type
Attic Hallway opening into all parts of attic
Door
Position A Night Air Circulation
Air drawn in through 1st and 2d story windows and circulated through attic space
Position B Day Air Circulation
Air drawn in through attic window and circulated through attic space
Second Story Rooms

Arrangement of Attic fan in Research Residence

RESULTS

Effectiveness of different methods of cooling with night air can be compared by plotting the drops in indoor temperatures from the time that indoor temperatures become identical to the time at which the indoor temperature attained a minimum against the drop in outdoor temperature from the times when the temperatures become identical to the time at which the outdoor temperature attained a minimum, as shown below, left. Maximum possible effectiveness shown in Curve 5, Graph 1. Since usually it is undesirable to keep first-story windows open all night, the most practical methods of operation are limited to those shown in Curves 1 and 2. Comparison of these shows that attic fan was slightly more effective than basement fan. Effectiveness of cooling with outdoor air at night was dependent on quantity of air circulated rather than upon method used. Curves indicate that effective cooling with outdoor air at night cannot be accomplished with less than 10 air changes per hour, and that above 30 air changes per hour, the gain resulting from increasing the amount of air is very small.



Influence of Rate of Circulation of Night Air on Cooling Effect in the Research Residence

COOLING WITH

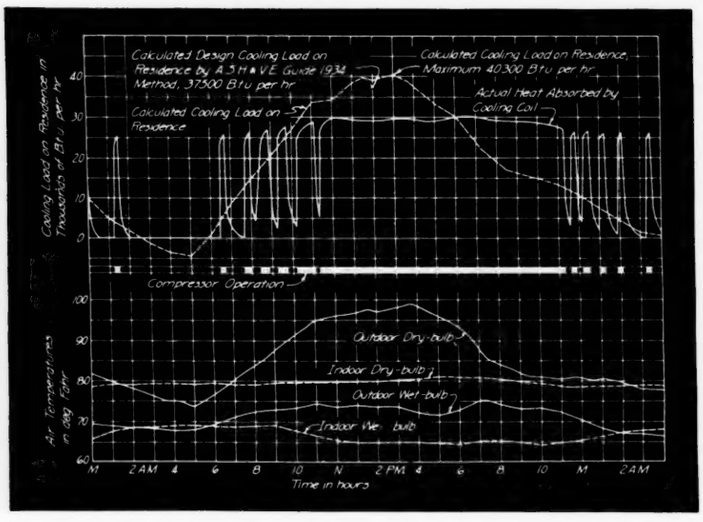
ELECTRICITY

TEST PLANT

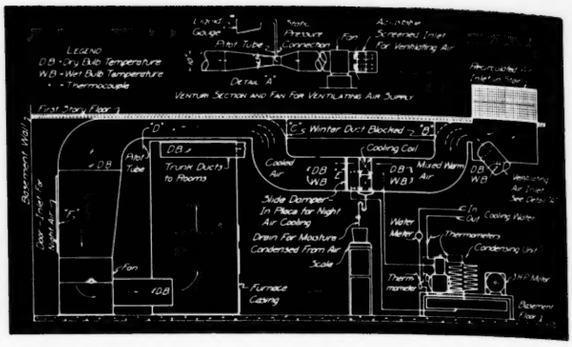
Test plant using mechanical refrigeration shown in drawing to the right. Four-cylinder compressor rated at 30,000 B.t.u. per hr., driven by 3-hp. motor. Direct expansion of refrigerant through extended surface coil in bypass of the central return duct. Winter return duct was tightly blocked at B and C. Amount of cooling controlled by room thermostat in hall on second story. Fan run continuously through both on and off periods of refrigerating unit, delivering approximately 1,300 c.f.m. of air. For ventilating, when plant was operating, one air change per hour of outdoor air was brought in through duct, as shown in detail A. For purpose of providing outdoor air for cooling at night, damper (E) was placed in bypass duct on downstream side of cooling coil, and a door (F) was placed in the recirculating duct near the fan inlet. When cooling with outdoor air at night, basement door and door in recirculating duct were open, damper closed.

TEST PROCEDURE

Two types of tests run. (A) With refrigeration during day and circulation of outdoor air at night, and (B) with only mechanical refrigeration during day. (A) At 7 a.m. outdoor air fan stopped and windows closed. Cooling plant started when thermostat reached 81F. Effective temperature maintained in residence at about 80F. Cooling plant stopped in evening when outdoor effective temperature dropped lower than indoor effective temperature. Then windows were opened and outdoor air system started. (B) Second-story windows closed during day and night and fan ran continuously, delivering through the cooling system recirculated and ventilation air. Cooling plant maintained average temperature of about 80F.

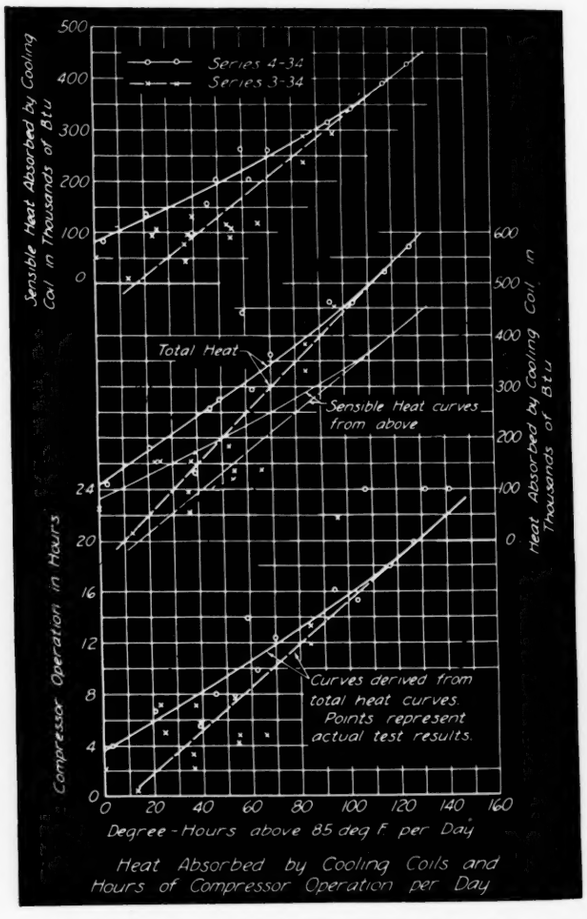

Calculated Design Cooling Load on Residence by A.S.H.&V.E. Guide 1934 Method, 37500 B.t.u. per hr.
Calculated Cooling Load on Residence, Maximum 40300 B.t.u. per hr.
Actual Heat Absorbed by Cooling Coil
Calculated Cooling Load on Residence
Cooling Load on Residence in Thousands of B.t.u. per hr.
Compressor Operation
Outdoor Dry-bulb
Indoor Dry-bulb
Outdoor Wet-bulb
Indoor Wet-bulb
Air Temperatures in Deg. F.
M 2 AM 4 6 8 10 N 2 PM 4 6 8 10 M 2 AM
Time in hours

Actual and calculated cooling load on residence and air temperatures for one day using mechanical refrigeration with no night air circulation.



RESULTS

Operating characteristics under procedure A shown at left below, excepting that operating period was usually several hours later than 6 a.m., and ratio of continuous operating period was much shorter, and the end of the intermittent operating period was usually before 10. During continuous operation indoor relative humidity was about 45%, and indoor effective temperature 73.5F. Indications are that these conditions are conducive to comfort in average residential cooling installations with major degree of activity, and that one air change per hour of outdoor air was sufficient to prevent objectionable odors. Data indicate that 2½-ton compressor sufficient for this house, this climate. Two lower curves below indicate 20% saving in compressor operation when using night air.


Series 4-34
Series 3-34
Sensible Heat Absorbed by Cooling Coil in Thousands of B.t.u.
Total Heat
Sensible Heat curves from above
Curves derived from total heat curves. Points represent actual test results.
Compressor Operation in Hours
Heat Absorbed by Cooling Coil in Thousands of B.t.u.
Degree-Hours above 85 deg F per Day
Heat Absorbed by Cooling Coils and Hours of Compressor Operation per Day

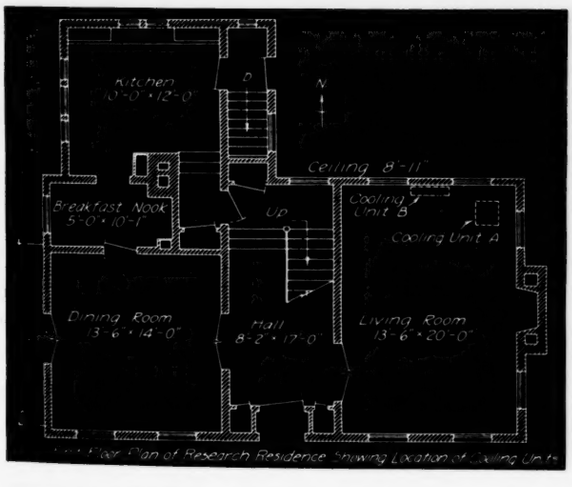
Relationship between degree-hours above 85F, compressor operation and heat absorbed. Series 4-34, no night air; Series 3-34, with night air.

TEST PLANT

The unit room coolers are shown at the right, and their location in the residence shown below. (A) was a portable ice cooler holding 300 lb. of ice, and with a fan for circulating the room air to the unit. Unit (B) was an ice tank of 500-ton capacity located in the basement with a cooling unit on the first floor, the cabinet enclosing an extended surface cooling coil, fan, and drip pan. Chilled water from the storage tank in the basement was pumped through the cooling coil over which warm air from the room was circulated by a fan. Operation of both units was controlled by a room thermostat, which served to start and stop the fan in accordance with the cooling requirements necessary for maintaining a constant air temperature.

TEST PROCEDURE

Indoor temperature of 80F maintained with both types of units. Units were started and placed under thermostatic control when the indoor effective temperature reached a predetermined value; continued to operate until the outdoor effective temperature became equal to the indoor effective temperature when they were stopped and the windows were opened. The majority of tests with unit (A) were made in living room. Direct cooling was confined to this room by closing the door leading to the hall. With unit (B) a pump circulated chilled water from the basement to the cabinet in the living room. Pump ran continuously during periods requiring cooling. The total cooling load or heat absorbed from the air was determined by the ice meltage, and the amount of dehumidification or moisture condensed from the air was determined by collecting and weighing the water which drained from the cooling coil. During most of tests with this unit door from living room to hall remained open, and unit was allowed to cool all of the first floor rooms which had a total volume of 7,300 cu. ft.



First Floor Plan of Research Residence Showing Location of Cooling Units

COOLING WITH ROOM UNITS

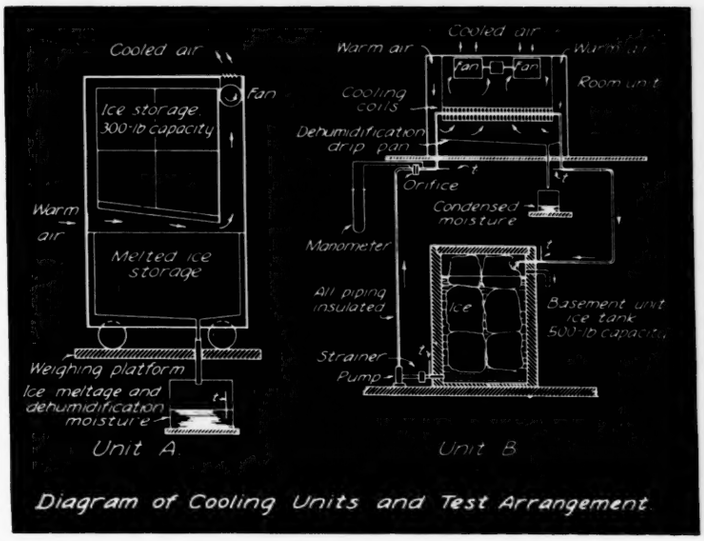


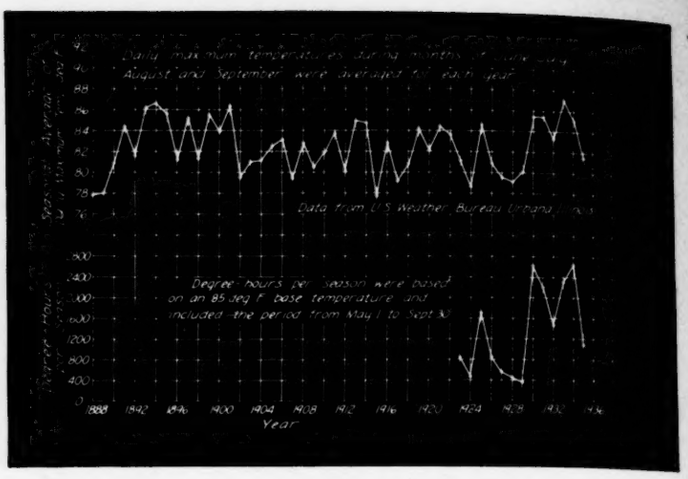
Diagram of Cooling Units and Test Arrangement

RESULTS

With unit (A), fluctuations in dry bulb temperature between on and off periods did not exceed 1.5F. Average drop in air temperature through the unit was 11F, and reduction in moisture content of air was 10½ gr. per lb. of dry air. Relative humidity in room was between 50 and 55%, as compared to 65 and 70% in adjoining hall which was not cooled. Tests with this unit were limited, and made during mild weather when outdoor temperature was not over 90F, so that cooling load should not be accepted as that of an average-sized room in a residence during a severe summer.

The typical day when cooling with basement unit and room unit (B), with outdoor temperature at a maximum of 94F, unit operated intermittently for 11.7 hr., maintaining 79.3F in living room, 81.5F in hall, 82.6F in dining room, and 82.1F in kitchen, an average of 81.4F for the first story. Maximum indoor temperature on the uncooled second story was 87.5F. Although the cooling unit and control thermostat were unfavorably located with respect to the center of the first story, the air temperatures in any one room did not deviate more than 2.1F from the mean temperature for the entire first story. The minimum temperature of 79.3F occurred in the living room where the cooling unit was located and the maximum temperature of 82.6F occurred in the dining room. Average initial relative humidity on first floor of 68% was reduced to 58% at the end of one hour's operation, and at end of five hours' operation had stabilized at about 50%. Average rate of heat absorption reduced to an equivalent ice melting capacity and expressed as tons of refrigeration was 0.59 tons. In general, performance of the unit and conditions attained on the first story were satisfactory. Undoubtedly, variation between rooms would have been improved by a more centralized location of the unit and control thermostat.

COSTS


Daily maximum temperatures during months of June, July, August and September were averaged for each year
Data from U.S. Weather Bureau Urbana, Ill.
Degree-hours per season were based on an 85 deg F. base temperature and included the period from May 1 to Sept 30
Degree-hours per Season
Year

Accompanying drawing shows graphical record of summer temperatures in Urbana from 1888 to 1935. Lower curve shows sharp variation in number of degree-hours for the season during which these tests were conducted, and not only indicates the difficulty of comparison between tests but also the futility of attempting to predict severity of summer weather. Operating costs in Table 1 are based on local water and power rates of 33 cents per 1,000 gal. and 3.1 cents per kw-hr., and a price of $4 per ton for ice. The author points out that probably the most legitimate comparison can be made from the next to the last column in Table 1.

Table 1 gives seasonal weather data and hourly operating data for the three types of central cooling plants operated in the Research Residence during the summers of 1932, 1934, and 1935, using ice, mechanical refrigeration, and water from the city water mains for cooling and dehumidifying the air. The operating costs are based on the actual measured ice, water, and power consumptions of the various units included in the systems, and when the plants were operating at normal capacity under approximately equilibrium conditions.

Table 2 gives an approximate idea as to the seasonal cost for cooling under various conditions. Calculations indicated that if east, south, and west windows of residence had been equipped with awnings for a whole season and cooling was done with ice, a saving of 32.5% would have been made with the awnings. The estimated seasonal operating costs with mechanical refrigeration indicate that supplementing the cooling by using night air would make possible a saving of 16.6% over using mechanical refrigeration alone.

In 1935, only one method of operating the central cooling plant when using water from the city water mains was employed. The windows were equipped with awnings and the mild summer made it possible to supplement the artificial cooling each day with the circulation of outdoor air at night. For this particular season and with the method of operation employed, the total seasonal operating costs were $36.91.

TABLE 1.—SEASONAL WEATHER DATA AND HOURLY OPERATING DATA FOR THE THREE TYPES OF CENTRAL COOLING PLANTS

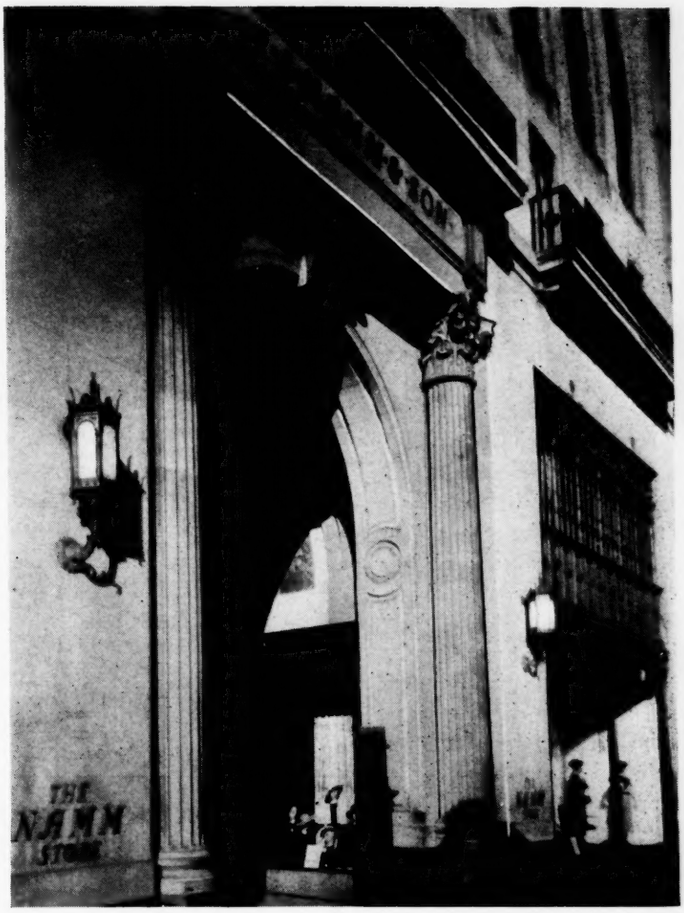
Season	Type of Plant	Total Degree-Hours Above 85F.	Indoor Conditions		Cooling Capactiy of Plant, B.t.u. per Hr.*	Operating Costs, Cents per Hour**				Total Cost per Hr. per Ton of Refrigeration Delivered, Cents†	Cost of Operating Fan for Night Air Cooling, Cents per Hr.
			Dry-Bulb Temp., F.	Relative Humidity, Per Cent		Ice	Water	Power	Total		
1932....	Ice.....	1470	78.0	45	31,700	44.00	—	2.37	46.37	17.55	—
1934....	Mechanical.....	2660	80.0	45	29,000	—	3.17	10.10	13.27	5.49	1.27
1935....	Water from City Mains	1180	80.0	65	24,000	—	11.88	1.34	13.22	6.61	1.37

*After Several Hours of Continuous Operation.
**Based on: Ice, $4.00 per Ton; Water, 33 Cents per 1000 Gal.; Power, 3.1 Cents per Kw.-hr.
†No capital costs taken into consideration.

TABLE 2.—SEASONAL OPERATING COSTS* (CALCULATED) FOR THE CENTRAL COOLING PLANTS

Season	Type of Cooling Plant	Total Degree-Hours Above 85F. Base	Operating Conditions		Seasonal Operating Costs in Dollars (Calculated)**				Ratio of Minimum to Maximum Seasonal Cost	Per Cent Reduction in Seasonal Operating Costs
			With or Without Awnings	With or Without Outdoor Air	Ice	Water	Power	Total		
1932....	Ice	1470	With	Without	161.20	—	13.36	174.56	0.678	32.2
			Without	Without	238.80	—	18.67	257.47		
1934....	Mechanical	2660	With	With	—	12.89	37.73	62.65	0.834	16.6
			With	Without	—	19.10	55.99	75.09		
1935....	Water from City Mains	1180	With	With	—	16.83	20.00	36.91	—	—

*Assuming that the Plants were Operated the Entire Season Under the Conditions Indicated.
**Based on the Following Rates:—Ice, $4.00 per Ton; Water, 33 Cents per 1000 Gal.; Power, 3.1 Cents per Kw.-hr.
No capital costs taken into consideration.



Department Store Heated and Cooled by Diesels

By JOSEPH F. KERN, Jr.†

ABOUT a year ago the executives of Namm's, a large Brooklyn, N. Y., department store, decided that their power costs were too high and something would have to be done to reduce them. After much deliberation it was decided to install a Diesel electric plant and an air conditioning system to supply electricity, hot water, heating and cooling for the store. The plant was to be entirely independent of the electric utilities without even an emergency connection.

In April of this year the plant, which is probably one of the most up to date in the country, was put into operation. The total cost is estimated to be $275,000, of which approximately $175,000 was spent for the Diesel plant and electrical connections and about $100,000 for the air conditioning system.

Diesel Engine Plant

The installation consists of four 200 k.w. Diesel engine generator sets running at 400 r.p.m., one 100 k.w. set running at 514 r.p.m. and a 200-ton refrigerating compressor, and two 50 k.w. motor generator sets, together with the necessary pumps, controls, storage tanks, switches and other accessories. It is expected that the plant will generate 2,400,000 k.w. hours per year with the maximum demand varying between 600 and 800 k.w. All the current is generated at 208 volts, 60 cycles, 3 phase. The motor generator sets were installed to provide direct current for the elevators.

It is estimated that the plant will pay for itself in six years and after that period the cost for electricity will be less than half of the utility charges.

Four of the five Diesel engines have a capacity of 300 h.p. each with a 10¾ in. bore and 14½ in. stroke, while the other unit is 150 h.p. with an 8 in. bore and 10½ in. stroke. All are of the six cylinder, four cycle type with solid injection. An alarm system is provided on all of the engines which warns the operator when the oil or water temperatures become excessive and oil or water pressures fail.

Engine Cooling Water

Cooling water for the engine is provided by a semi-closed system to avoid trouble from scale. Water is

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taken from a surge tank and passes through a cooler. Here it is cooled by water at approximately 65F which is obtained from a 100 ft. well located beneath the store.

This well has an outer casing of 30 in. and an inner casing of 12 in. and is capable of delivering 600 gallons per minute. Before this well water flows through the cooler it passes through extended surface coils placed in the duct which carries ventilating air to the engine room. This tends to slightly cool the air before it enters the room. After leaving the ventilation air cooling coils, the water flows to the Diesel water cooler. The hot well water from the cooler must be discharged back into the ground because under a ruling of the New York Water Conservation Board all ground water pumped from Long Island must be returned. A large diffusing well is provided for the return water.

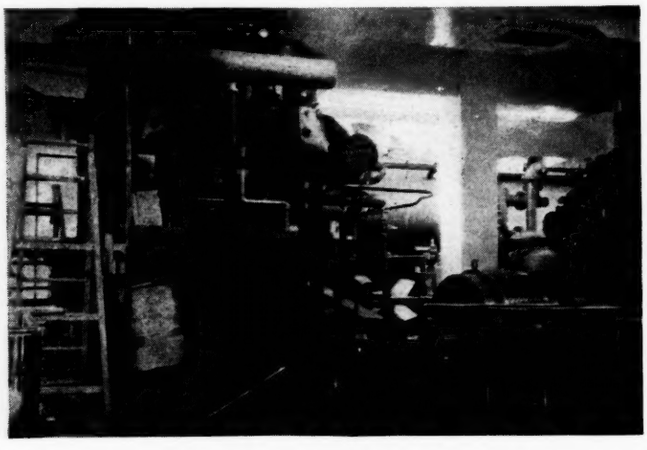
Getting back to the cooling water system of the Diesel engine. After leaving the cooler the water flows into the Diesel engine. Automatic flow valves allow sufficient water to enter the cooling system of each engine so that the outlet temperature will be 130F. This 130F water then is pumped back into the surge tank.

An unusual feature about this surge tank is that it is divided into two sections and, although the hot water from the Diesel engine enters the one section, the water which comes back to the engine is taken out of the other section. Only the excess water from the first section which overflows into the other section is returned to the engine cooling system. A float switch located in this chamber of the surge tank automatically supplies water from the city mains to the engine cooling system to make up for the water which is removed in the first chamber.

From the first section which stores 130F water is taken the water which flows to the supply hot water system of the building. This supply hot water is further heated by passing it through two exhaust heaters and into a 1,000-gallon storage tank. These two exhaust heaters remove the heat from the exhaust gases of two of the larger Diesel engines.

Refrigerating Compressor

One of the 300 h.p. Diesel engines has connected to it, besides the 200 k.w. generator, a 200-ton refrigerating compressor. Between the generator and the compressor is a coupling which makes it possible to disconnect the compressor when it is not required. This arrangement of having both a generator and compressor on the same shaft eliminates the inefficiency which would result when the compressor is running at small loads. By this arrangement the engine can be kept running at its most efficient load, though there is only a light load due to the compressor. In other words, any fluctuations in the load on the compressor is taken up by increasing or decreasing the load on the generator. A system of compressor unloader valves is used to meet changes in the air conditioning load.



The refrigerating compressor for air conditioning is directly connected to the generator which in turn is driven by a 300-hp. Diesel. Photo taken during erection of compressor.

A section of the basement showing air supply duct.

The compressed Freon refrigerant is passed from the compressor through a shell and tube type condenser. This condenser is cooled by water taken from the well. The liquid refrigerant then flows to an evaporator where it is used to cool water for use in the air conditioning units.

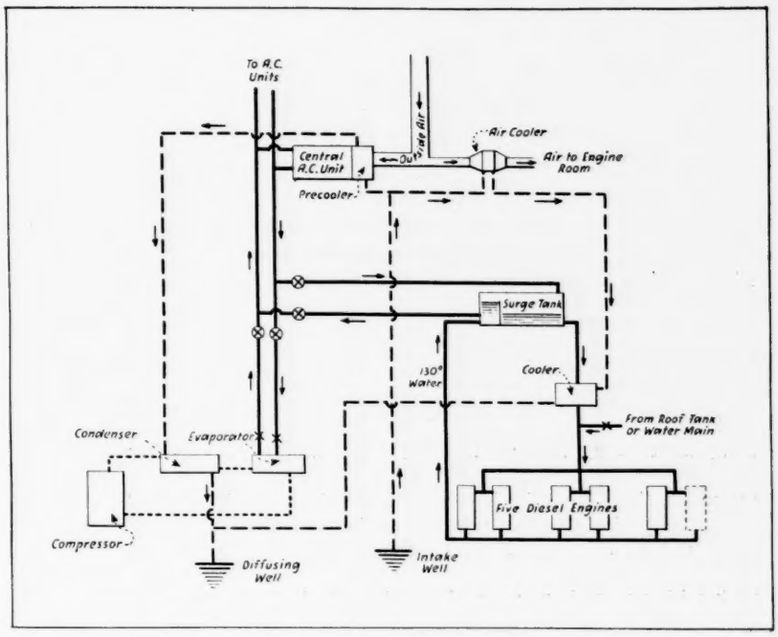
Air Conditioning System

The air conditioning system which cools the basement, street floor and one room on the second floor is of the semi-central type. One central unit on each floor supplies outside air while the other units merely recirculate the air. There are three units in the basement, one central and two recirculating, five units on the street floor, one central and four recirculating and one recirculating unit in the women's dressing room on the second floor.

All of the outside air is obtained from the roof of the store by means of a central shaft. This shaft is capable of supplying approximately 50,000 c.f.m. Of this, 10,000 c.f.m. is used to cool the engine room, 5,000 c.f.m. is supplied to the engines by means of a duct under the engine room floor and 35,000 c.f.m. is supplied to the store. About 10 c.f.m. of outside air is provided for each occupant.

An exhaust system is used to prevent the odors from the basement from reaching the ground floor. In the basement, exhaust fans are provided which have a somewhat greater capacity than the basement supply and therefore air is drawn down from the first floor, preventing the odors from the cafeteria, butcher shop and shoe shop from reaching the ground floor.

Schematic diagram of the apparatus used for heating and air conditioning. Well water is used for precooling the air to the store and engine room as well as for cooling the Diesel engines.



The air conditioning units vary in size from 1,500 to 10,000 c.f.m. Sufficiently chilled water is supplied by the refrigeration system so that a temperature of 80F with a relative humidity of 50% can be maintained in the store when the outside conditions are 95F dry bulb and 75F wet bulb.

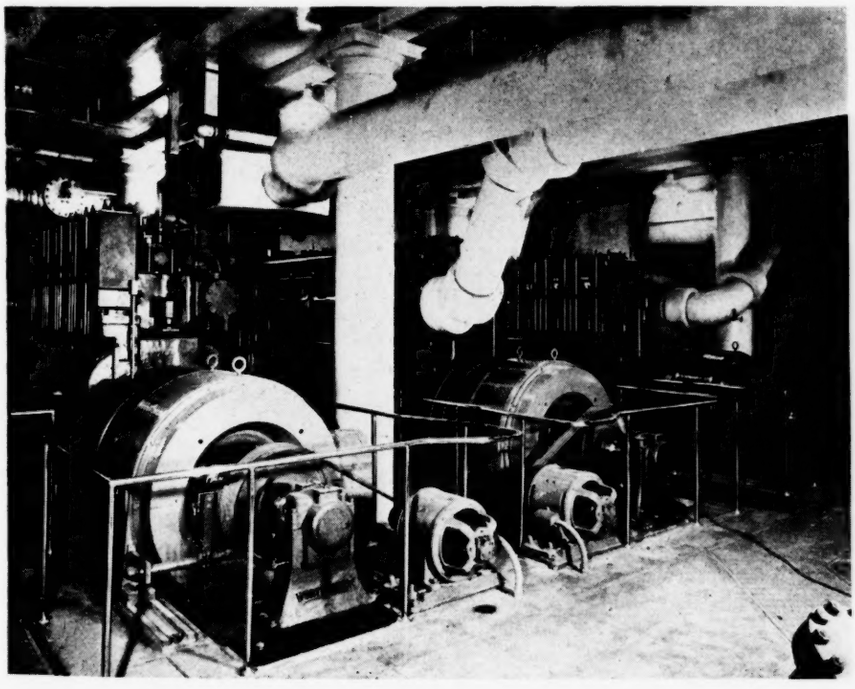
The two central units which supply outside air to the basement and first floors have two sets of cooling coils in them. The first set which cools outside air has water supplied to it from the well water system. The water which is at about 63F is expected to furnish about 100 tons of cooling. After the well water is discharged from the cooling coils, it flows back to the engine room where it is used to cool the hot refrigerant in the condenser. The second set of coils in the conditioning unit is supplied with chilled water from the refrigerating compressor and is used to cool both the recirculated air and the pre-cooled outside air. The other recirculating units in the basement, first and second floors, are supplied only with chilled water.

Winter Air Conditioning

During the winter, advantage will be taken of the large amount of hot water which is available from the engine cooling system to heat the basement and first floors of the store. Piping has been supplied which will take the 130F hot water from the first chamber in the surge tank and carry it to the coils in the air conditioning system. It is expected that the water will return cool enough to use in the engines without further cooling by well water.

None of the radiators have been removed from the basement and the first floor so that if there is not enough heat available from the Diesel cooling water, additional heat can be supplied by the old heating system.

The combined air conditioning and Diesel plant was designed by Huxley Madehein and Henry Rosenthal, consulting engineers, under the supervision of Richard S. Elwell, vice-president of the Namm Store. The Diesel engines were supplied by the Worthington Pump & Machinery Corporation, while the refrigeration equipment was supplied by the Carbondale Machine Corporation, and installed together with the remaining air conditioning equipment by the Carbondale New York Co. The operating engineer of the plant is Harry Waite.



A corner of the engine room showing three of the large Diesel engines and generators. On the ceiling near the left can be seen the heat exchanger which removes the heat from the flue gases.

What Are the Facts About Residential Air Conditioning?

DO you believe that homeowners should pass up air conditioning until the industry has put several more years of careful research into considering what is possible and desirable for the average householder? Are too many concerns with little financial backing and practically no engineering staffs offering air conditioning equipment to homeowners and most of which will never operate satisfactorily? Have large installations in many instances proved wholly unsatisfactory? Is home air conditioning equipment noisy to an annoying degree? Is it true that many systems have rusted out in a few seasons' runs because of circulating highly humid air through the ducts? Is the cost of air conditioning one's home or even a single room out of all proportion to the benefits to be derived from it? Does an air conditioning system increase the ease with which your house may burn down? Is it common for persons to catch head colds in a 70F room on a hot day? Is the equipment offered too elaborate and in no way related to the needs of the homeowner?

The writer of the article partially reprinted below asserts that the answer to all these—and more—is yes. I believe you will want to read the article thoughtfully for it is probably the most sweeping indictment of this industry which has appeared in the press of late.

For the past five years the idea of air conditioning for comfort has spread amazingly. It has been helped by the almost unanimous support of the press both general and technical. Articles similar to that reproduced below have been so rare as to be almost non-existent. Perhaps more surprising than the appearance of the article is the fact that Mr. Palmer is, according to a note in the "New Republic" issue, "an engineer and physicist."

My attention was first called to the article when a friend wrote in about it and when someone else sent a copy of the magazine through the mail. Naturally, I found it interesting reading. The first reaction was to resent it. The next was to wonder how well qualified Mr. Palmer was to write it for certainly I thought he was misinterpreting a good many points.

After a little further thought it got to be pretty apparent that there is certainly nothing to be gained by getting upset. Moreover, it is also clear that the best way to stop such critical comments and to insure the continuance of a favorable press is to open the subject wide and not try to stifle or suppress unfavorable comment.

Instead, let us in the industry—we, who of all people should have the facts regarding these points in our possession—go out and demonstrate the facts of the matter. Nothing is so disconcerting to a critic as to be confronted with well-ordered arguments backed up by facts which cannot be talked down.

What is more, the whole industry should be in possession of the arguments and the facts. The pages of HEATING & VENTILATING are at your disposal for any constructive comments or suggestions as well as for presenting any fact-backed arguments. Here is a real challenge to the industry and especially to its engineers to bring forth the facts in a way that will carry conviction.—*C. H. B. Hotchkiss.*

AIR conditioning is on its way. It is believed by the heating and ventilating industry that the majority of home owners still have some ready money or can borrow enough to try out the novel experience of keeping cool when the weather is hot. It looks as if the experience is going to cost the home owners of this country plenty.

The term "air conditioning" is finding universal application. The magic expression is used to describe such articles as fans, humidifiers, odor absorbers and even underwear and hats. The manufacturers of a radiator evaporator were called to task by the Federal Trade Commission for referring to this gadget as an "air conditioner." The Guthfan—an electric fan attached to the ceiling—is referred to as a "Conditionaire." The Continental Motors Corporation has introduced a portable air conditioner that is thirteen inches high, ten inches wide, seven inches deep, weighs ten pounds and sells for $13.50. This tricky little device "will enable you to revel in an atmosphere as fresh and pure as that of a breeze-swept lakeside. The air you breathe will be clean and free from soot, dust, smoke and pollen . . . Humidifies and washes air—deodorizes—a wonderful relief for rose and hay-fever sufferers." Why bother with cluttering up your house with a $2,000 outfit when so much can be had for only $13.50?

But to Crosley Radio Corporation goes the credit for a really unique application of air-conditioning science. Only recently an advanced showing was made at the Crosley factory of the latest improvements in the Crosley cool-rest, air-conditioned bed with a new de-luxe canopy. Surely no one will argue that he cannot afford an air-conditioned bed!

Refrigerating the living quarters of America's urban population is not the simple and logical next step in an advancing technical state that some promoters of the new mechanized life would have us believe. Keeping the air around meat and vegetables in a refrigerator at the proper temperature and humidity is one thing, but cooling and controlling the humidity of the air in the average or even better than average house is something entirely different.

A refrigerator is tightly constructed with walls of insulating material anywhere from two to four inches thick. American houses are notoriously leaky structures. Coal has been cheap, hence it has not been necessary to build tight, well insulated homes. Ice boxes and refrigerators usually have one large storage compartment—houses consist of many rooms, necessitating the use of a forced-air system with elaborate ducts and vents to cool all space uniformly. A carrot or a bottle of milk will show no effects from temperature and humidity variations within certain limits—a maiden aunt won't put up with comparable variations in the household air. Sensitive controls must be installed and maintained to keep the properties of the air constant. . . .

Human beings are not in any great need of conditioned air, but an expanding refrigeration and ventilating industry is going to give it to them whether or no. The industry has resorted to "made business" before and can do it again. . . .

The elaborate form that modern air-conditioning equipment has taken is chiefly the result of the industry's drive to sell expensive installations and is in no way related to the needs of the home owner barely able to keep up with the payments on his home. The same industrial and professional engineering groups that sold plenum systems to the state legislators wou'd now like to force expensive air-conditioning plants into every house.

The chief sales appeal for air conditioning is built around summer comfort—as the hot summer months approach, interest in cooling equipment increases. It is generally implied in sales literature that if your house or office is

cool, your health will improve accordingly. In advertising to industry, manufacturers of air-conditioning systems are making much of the reduction of time lost from work as a result of installing air-conditioning equipment. Actually there are few or no experimental data to substantiate any of these claims. Dr. W. J. McConnell of the Industrial Health Section of the Metropolitan Life Insurance Company stated recently in a paper on "Investigations of the Health Aspect of Air Conditioning" that whatever effects air conditioning may have are in general not directly measurable, that studies on employee absenteeism in two buildings, one air-conditioned and one not, of the Metropolitan Life, each of which houses about 6,000 workers, showed no measurable difference between employees in the two buildings. It is Dr. McConnell's opinion that there is some evidence to show that air conditioning is beneficial in certain medical techniques, such as special room treatment for some forms of hay fever, and some specialized treatments in anemia and in some allergic diseases. In general, however, there are no data which show conclusively that conditioned air is beneficial to health.

On the other hand, there is enough evidence available to show that the large temperature differences to which a person is subject when going from a cool air-conditioned building to the street on a hot summer day may have certain detrimental effects on the health. Dr. Lloyd Arnold, professor of Bacteriology and Public Health of the College of Medicine, University of Illinois, has stated that the so-called "comfort zone" (about 70°) maintained in many theaters and public buildings is too far below outside temperatures for persons to make a quick adjustment when going from one temperature to another. In some cases this temperature difference amounts to as much as 20°. It is common for persons to catch head colds in a 70° room on a hot day, and many persons feel dizzy, or even collapse, when they come out of such a room into a 90° outside temperature. Dr. Arnold believes that differences between inside and outside temperatures should not be more than 10° Fahrenheit and possibly less, with a relative humidity between 40 and 50 per cent.

There are other hazards that accompany air-conditioning systems about which one seldom hears. In the comparatively large cooling systems necessary to maintain a house at a comfortable temperature in hot weather, the quantity of refrigerants may be dangerously high. Any slight leak in the refrigerating plant will result in the toxic fumes (sulphur dioxide and ammonia are commonly used) being quickly spread to all parts of the house. This hazard should not be minimized. Dr. C. S. Cragoe, senior physicist, Bureau of Standards, has recently urged that due consideration be given to this question of safety "in order that a major tragedy might not take place and give the air-conditioning business a bad setback."

An air-conditioning system also increases the ease with which your house may burn down. This hazard lies principally in the ducts through which smoke and hot gases can quickly spread from one room to another. Fires in the air ducts are difficult to fight, and large fire losses may be expected where such ducts are made of or lined with combustible materials or where they are of metal in contact with wood floors and partitions.

The cost of air-conditioning one's home or even a single room is out of all proportion to the benefits to be derived from it. One experimental installation in the now famous "Detroit Edison Research Residence" shows that when conditions are nearly ideal the costs involved are prohibitive for all save a very small fraction of home owners. While actual installations and equipment costs are not given, they must have been in the neighborhood of $400 for the two-ton refrigerating system used. The operating cost for one season was $11.96. The industry cites this as an example of the low cost of residential summer cooling. Careful study of the data, however, reveals that the artificial cooling system was only in operation for fourteen days during the whole season—that is, it actually cost 85 cents a day to operate the system. This cost of course did not include any interest on the investment or depreciation, although fixed charges amount to three or four times as much as operating costs alone. With these included, the total cost was about $3 a day. This estimate still omits the very large additional outlay to prepare the house for cooling—such as specially insulated walls and the use of awnings and blinds to keep out the sun.

In order to keep the cost of operating the cooling system down as low as possible, no outside air was drawn into the cooling air during the period of operation. This in spite of the fact that the heating and ventilating industry, in putting its program over in the schools, insisted that thirty cubic feet per person per minute of outside fresh air was essential.

Home owners are being asked to invest several hundred dollars in cooling equipment that will operate at most in a city with summer temperatures comparable to those of Detroit about thirty days, and only twenty days in a normal summer.

If the air-conditioning system is complete it must also, as previously stated, take care of heating and humidifying the home air in the winter. Equipment at all adequate for a seven or eight-room house will cost not less than $2,500 and probably more when completely installed. Additional problems are also presented in such combined heating and humidifying plants. For example, if the temperature of the air is kept at 70° (a common requirement for most Americans who insist upon hothouse temperatures) and if an attempt is made to keep the relative humidity at a reasonable and comfortable point—about 50 per cent—moisture will be deposited on all surfaces that are 40° or lower. This results in windows and doors becoming heavily coated with frost, and attics have been known to become literally snowbound. The only solution to this problem is to reduce room temperatures to around 66-68 degrees, and it then becomes possible to keep the humidity at a reasonable point without frost forming on all cold surfaces. Keeping humid air circulating by means of a blower or fan through metal ducts will result in rapid rusting and deterioration of all metal surfaces if the best of materials are not used. Many systems have rusted out in the course of a few seasons' run.

All air-conditioning systems are noisy, some more so than others. Home owners can expect considerable annoyance from their installations in this respect if the equipment is not carefully placed and mounted in such a way that fan noises and vibrations are not carried to all parts of the house.

At the present time the most satisfactory installation of air-conditioning equipment has been in large units, such as those used in theatres, restaurants, trains, etc., where the investment has justified the expense of engaging the services of the best heating and ventilating experts available. But in many instances even the large installations have proved wholly unsatisfactory. . . .

If this situation is at all representative of large air-conditioning installations, it is far more true of the smaller equipment now installed or being offered for private residences, where it is not possible to engage the services of a consultant engineer to lay out the system and check on all the important details of the installation. Far too many concerns with little financial backing and practically no engineering staffs are offering "air-conditioning" equipment to home owners. The majority of such units will never operate satisfactorily.

Home owners paid a terrific price in cold cash and headaches for empirically designed heating appliances when the oil-burner industry was getting under way. They will save themselves another thorough shakedown if they will pass up air conditioning until the industry has put several more years of careful research into considering what is possible and desirable for the average householder. At the end of that time we may all conclude that treated air is not the great benefactor that it has been advertised to be.—THE COST OF CONDITIONED AIR, Dewey H. Palmer, in "The New Republic," July 29, 1936.

What Are the Facts About Residential Air Conditioning?

DO you believe that homeowners should pass up air conditioning until the industry has put several more years of careful research into considering what is possible and desirable for the average householder? Are too many concerns with little financial backing and practically no engineering staffs offering air conditioning equipment to homeowners and most of which will never operate satisfactorily? Have large installations in many instances proved wholly unsatisfactory? Is home air conditioning equipment noisy to an annoying degree? Is it true that many systems have rusted out in a few seasons' runs because of circulating highly humid air through the ducts? Is the cost of air conditioning one's home or even a single room out of all proportion to the benefits to be derived from it? Does an air conditioning system increase the ease with which your house may burn down? Is it common for persons to catch head colds in a 70F room on a hot day? Is the equipment offered too elaborate and in no way related to the needs of the homeowner?

The writer of the article partially reprinted below asserts that the answer to all these—and more—is yes. I believe you will want to read the article thoughtfully for it is probably the most sweeping indictment of this industry which has appeared in the press of late.

For the past five years the idea of air conditioning for comfort has spread amazingly. It has been helped by the almost unanimous support of the press both general and technical. Articles similar to that reproduced below have been so rare as to be almost non-existent. Perhaps more surprising than the appearance of the article is the fact that Mr. Palmer is, according to a note in the "New Republic" issue, "an engineer and physicist."

My attention was first called to the article when a friend wrote in about it and when someone else sent a copy of the magazine through the mail. Naturally, I found it interesting reading. The first reaction was to resent it. The next was to wonder how well qualified Mr. Palmer was to write it for certainly I thought he was misinterpreting a good many points.

After a little further thought it got to be pretty apparent that there is certainly nothing to be gained by getting upset. Moreover, it is also clear that the best way to stop such critical comments and to insure the continuance of a favorable press is to open the subject wide and not try to stifle or suppress unfavorable comment.

Instead, let us in the industry—we, who of all people should have the facts regarding these points in our possession—go out and demonstrate the facts of the matter. Nothing is so disconcerting to a critic as to be confronted with well-ordered arguments backed up by facts which cannot be talked down.

What is more, the whole industry should be in possession of the arguments and the facts. The pages of HEATING & VENTILATING are at your disposal for any constructive comments or suggestions as well as for presenting any fact-backed arguments. Here is a real challenge to the industry and especially to its engineers to bring forth the facts in a way that will carry conviction.—*C. H. B. Hotchkiss.*

AIR conditioning is on its way. It is believed by the heating and ventilating industry that the majority of home owners still have some ready money or can borrow enough to try out the novel experience of keeping cool when the weather is hot. It looks as if the experience is going to cost the home owners of this country plenty.

The term "air conditioning" is finding universal application. The magic expression is used to describe such articles as fans, humidifiers, odor absorbers and even underwear and hats. The manufacturers of a radiator evaporator were called to task by the Federal Trade Commission for referring to this gadget as an "air conditioner." The Guthfan—an electric fan attached to the ceiling—is referred to as a "Conditionaire." The Continental Motors Corporation has introduced a portable air conditioner that is thirteen inches high, ten inches wide, seven inches deep, weighs ten pounds and sells for $13.50. This tricky little device "will enable you to revel in an atmosphere as fresh and pure as that of a breeze-swept lakeside. The air you breathe will be clean and free from soot, dust, smoke and pollen . . . Humidifies and washes air—deodorizes—a wonderful relief for rose and hay-fever sufferers." Why bother with cluttering up your house with a $2,000 outfit when so much can be had for only $13.50?

But to Crosley Radio Corporation goes the credit for a really unique application of air-conditioning science. Only recently an advanced showing was made at the Crosley factory of the latest improvements in the Crosley cool-rest, air-conditioned bed with a new de-luxe canopy. Surely no one will argue that he cannot afford an air-conditioned bed!

Refrigerating the living quarters of America's urban population is not the simple and logical next step in an advancing technical state that some promoters of the new mechanized life would have us believe. Keeping the air around meat and vegetables in a refrigerator at the proper temperature and humidity is one thing, but cooling and controlling the humidity of the air in the average or even better than average house is something entirely different.

A refrigerator is tightly constructed with walls of insulating material anywhere from two to four inches thick. American houses are notoriously leaky structures. Coal has been cheap, hence it has not been necessary to build tight, well insulated homes. Ice boxes and refrigerators usually have one large storage compartment—houses consist of many rooms, necessitating the use of a forced-air system with elaborate ducts and vents to cool all space uniformly. A carrot or a bottle of milk will show no effects from temperature and humidity variations within certain limits—a maiden aunt won't put up with comparable variations in the household air. Sensitive controls must be installed and maintained to keep the properties of the air constant. . . .

Human beings are not in any great need of conditioned air, but an expanding refrigeration and ventilating industry is going to give it to them whether or no. The industry has resorted to "made business" before and can do it again. . . .

The elaborate form that modern air-conditioning equipment has taken is chiefly the result of the industry's drive to sell expensive installations and is in no way related to the needs of the home owner barely able to keep up with the payments on his home. The same industrial and professional engineering groups that sold plenum systems to the state legislators wou'd now like to force expensive air-conditioning plants into every house.

The chief sales appeal for air conditioning is built around summer comfort—as the hot summer months approach, interest in cooling equipment increases. It is generally implied in sales literature that if your house or office is

cool, your health will improve accordingly. In advertising to industry, manufacturers of air-conditioning systems are making much of the reduction of time lost from work as a result of installing air-conditioning equipment. Actually there are few or no experimental data to substantiate any of these claims. Dr. W. J. McConnell of the Industrial Health Section of the Metropolitan Life Insurance Company stated recently in a paper on "Investigations of the Health Aspect of Air Conditioning" that whatever effects air conditioning may have are in general not directly measurable, that studies on employee absenteeism in two buildings, one air-conditioned and one not, of the Metropolitan Life, each of which houses about 6,000 workers, showed no measurable difference between employees in the two buildings. It is Dr. McConnell's opinion that there is some evidence to show that air conditioning is beneficial in certain medical techniques, such as special room treatment for some forms of hay fever, and some specialized treatments in anemia and in some allergic diseases. In general, however, there are no data which show conclusively that conditioned air is beneficial to health.

On the other hand, there is enough evidence available to show that the large temperature differences to which a person is subject when going from a cool air-conditioned building to the street on a hot summer day may have certain detrimental effects on the health. Dr. Lloyd Arnold, professor of Bacteriology and Public Health of the College of Medicine, University of Illinois, has stated that the so-called "comfort zone" (about 70°) maintained in many theaters and public buildings is too far below outside temperatures for persons to make a quick adjustment when going from one temperature to another. In some cases this temperature difference amounts to as much as 20°. It is common for persons to catch head colds in a 70° room on a hot day, and many persons feel dizzy, or even collapse, when they come out of such a room into a 90° outside temperature. Dr. Arnold believes that differences between inside and outside temperatures should not be more than 10° Fahrenheit and possibly less, with a relative humidity between 40 and 50 per cent.

There are other hazards that accompany air-conditioning systems about which one seldom hears. In the comparatively large cooling systems necessary to maintain a house at a comfortable temperature in hot weather, the quantity of refrigerants may be dangerously high. Any slight leak in the refrigerating plant will result in the toxic fumes (sulphur dioxide and ammonia are commonly used) being quickly spread to all parts of the house. This hazard should not be minimized. Dr. C. S. Cragoe, senior physicist, Bureau of Standards, has recently urged that due consideration be given to this question of safety "in order that a major tragedy might not take place and give the air-conditioning business a bad setback."

An air-conditioning system also increases the ease with which your house may burn down. This hazard lies principally in the ducts through which smoke and hot gases can quickly spread from one room to another. Fires in the air ducts are difficult to fight, and large fire losses may be expected where such ducts are made of or lined with combustible materials or where they are of metal in contact with wood floors and partitions.

The cost of air-conditioning one's home or even a single room is out of all proportion to the benefits to be derived from it. One experimental installation in the now famous "Detroit Edison Research Residence" shows that when conditions are nearly ideal the costs involved are prohibitive for all save a very small fraction of home owners. While actual installations and equipment costs are not given, they must have been in the neighborhood of $400 for the two-ton refrigerating system used. The operating cost for one season was $11.96. The industry cites this as an example of the low cost of residential summer cooling. Careful study of the data, however, reveals that the artificial cooling system was only in operation for fourteen days during the whole season—that is, it actually cost 85 cents a day to operate the system. This cost of course did not include any interest on the investment or depreciation, although fixed charges amount to three or four times as much as operating costs alone. With these included, the total cost was about $3 a day. This estimate still omits the very large additional outlay to prepare the house for cooling—such as specially insulated walls and the use of awnings and blinds to keep out the sun.

In order to keep the cost of operating the cooling system down as low as possible, no outside air was drawn into the cooling air during the period of operation. This in spite of the fact that the heating and ventilating industry, in putting its program over in the schools, insisted that thirty cubic feet per person per minute of outside fresh air was essential.

Home owners are being asked to invest several hundred dollars in cooling equipment that will operate at most in a city with summer temperatures comparable to those of Detroit about thirty days, and only twenty days in a normal summer.

If the air-conditioning system is complete it must also, as previously stated, take care of heating and humidifying the home air in the winter. Equipment at all adequate for a seven or eight-room house will cost not less than $2,500 and probably more when completely installed. Additional problems are also presented in such combined heating and humidifying plants. For example, if the temperature of the air is kept at 70° (a common requirement for most Americans who insist upon hothouse temperatures) and if an attempt is made to keep the relative humidity at a reasonable and comfortable point—about 50 per cent—moisture will be deposited on all surfaces that are 40° or lower. This results in windows and doors becoming heavily coated with frost, and attics have been known to become literally snowbound. The only solution to this problem is to reduce room temperatures to around 66-68 degrees, and it then becomes possible to keep the humidity at a reasonable point without frost forming on all cold surfaces. Keeping humid air circulating by means of a blower or fan through metal ducts will result in rapid rusting and deterioration of all metal surfaces if the best of materials are not used. Many systems have rusted out in the course of a few seasons' run.

All air-conditioning systems are noisy, some more so than others. Home owners can expect considerable annoyance from their installations in this respect if the equipment is not carefully placed and mounted in such a way that fan noises and vibrations are not carried to all parts of the house.

At the present time the most satisfactory installation of air-conditioning equipment has been in large units, such as those used in theatres, restaurants, trains, etc., where the investment has justified the expense of engaging the services of the best heating and ventilating experts available. But in many instances even the large installations have proved wholly unsatisfactory. . . .

If this situation is at all representative of large air-conditioning installations, it is far more true of the smaller equipment now installed or being offered for private residences, where it is not possible to engage the services of a consultant engineer to lay out the system and check on all the important details of the installation. Far too many concerns with little financial backing and practically no engineering staffs are offering "air-conditioning" equipment to home owners. The majority of such units will never operate satisfactorily.

Home owners paid a terrific price in cold cash and headaches for empirically designed heating appliances when the oil-burner industry was getting under way. They will save themselves another thorough shakedown if they will pass up air conditioning until the industry has put several more years of careful research into considering what is possible and desirable for the average householder. At the end of that time we may all conclude that treated air is not the great benefactor that it has been advertised to be.—THE COST OF CONDITIONED AIR, Dewey H. Palmer, in "The New Republic," July 29, 1936.

Are Estimates of Heat Loss High?

Calculations involving fuel consumption of a heating plant are frequently found to differ sharply from actual requirements. Recent investigations indicate that our commonly used methods of computing heat loss are high, but the difficulty is to locate just where the error lies. This article summarizes the results of two studies on this subject, one by Giesecke and Badgett at Texas A. & M., the other by Houghten and Gutberlet at Pittsburgh. Both are research projects of the ASHVE, the former being a cooperative study by the Society and the College

IT has been well recognized for a long time that the most frequently advocated method of computing building heat losses is somewhat too generous. This has been felt to be not too serious, inasmuch as it allows a factor of safety. However, from the standpoint of contractors and others making competitive bids, this method of computation has been sufficient to cause them to overestimate heating plant capacities to such an extent that resulting higher cost has lost the job to others using less cautious methods.

Another disadvantage of the method is that calculations and estimates involving fuel consumption or heat consumption are too high, in some cases to an important degree.

Lately, some evidence has been gathered to show the amount by which heat transmission calculations erred on the side of safety. A particularly good example is the series of tests run in the building housing the Texas Engineering Experiment Station at Texas A. and M. College. The building is heated by a centrally located hot water system and, by measuring the amount of water flowing through the building and its temperature when entering and leaving, the heat utilized in the building could be simply and accurately determined. Outdoor temperatures are measured by a recording thermometer and indoor temperatures were taken at a large number of different points both with the indicating thermometer and the recording thermometer. Wind velocities were recorded above the roof of the building. The heat requirements of the building were computed by the procedure recommended in the 1935 Guide, based on an outdoor design temperature of 25F and a wind velocity of 15 m.p.h. from the north to northwest. No empirical exposure factors were used to increase the calculated heat losses on the side of the building exposed to prevailing winds. Air leakage was determined by the crack infiltration method as outlined in the Guide.

The tests were run on cloudy days so as to eliminate the effect of solar radiation from the calculations. This method, though, did not make allowance for heat lag—heat which remained in the building from solar radiation and other sources from the previous day. At any rate, the result of calculations for observations made during seven 24-hr. periods in January and February, 1936, showed that the estimated heat requirements averaged 23% higher than the actual heat requirements, the estimated heat requirements being determined by multiplying the average temperature difference for each hour by the estimated hourly heat loss per degree temperature difference. The weather conditions during the tests were as near design conditions as possible; namely, with an outdoor temperature of 25F and a wind velocity from the north of approximately 15 m.p.h. There was no precipitation on any of the days for which tests were reported except a very light snow on one of the mornings.

The 23% error in the estimated heat requirements as compared with actual requirements is obviously high. Consequently, the cracks between the steel sash and the window frame were measured with a thickness gage on a number of windows in the building to determine whether too much infiltration had been allowed for in the calculations. This was found to be the case and the heat requirements were re-estimated using a smaller allowance for infiltration. The error was then reduced to an average of 12.6% more estimated heat than was required.

The accompanying curve, from the Texas tests, Fig. 1, summarizes the effect of average wind velocity on estimated heat requirements and shows that there is a definite trend between wind velocity and variation between the estimated and actual heat requirements of a building. Thus it appears from these tests that a great source of error in estimating heat losses of a building lies in the calculations dealing with air infiltration.

An additional fact noted during the tests was that on days when the sun was shining the effect was immediately discernible in rooms exposed to the sun. The temperature in these rooms rose rapidly to 10F above that when the sun was not shining, while the temperature in shaded rooms remained normal.

Over two years ago similar tests were run in an office building at Pittsburgh and these tests have recently been analyzed in

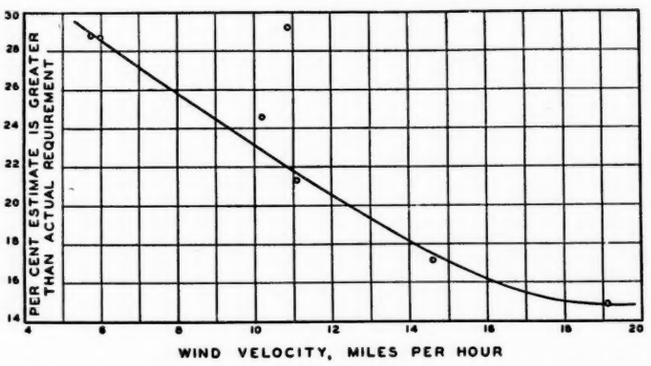


Fig. 1. Curve showing how much greater estimated heat requirements are above actual requirements, depending on wind velocity. From tests of a building in Texas.

considerable detail in an attempt to determine the relationship between the heat requirements of rooms and weather conditions with particular emphasis on outside temperature, wind velocity and direction and solar radiation.

The rooms studied are in the 40-story Grant Building, one of Pittsburgh's finest skyscrapers. The rooms were heated between approximately 8 a.m. and 10 p.m. by electrical resistance heating units, so that the heat input to the rooms could be accurately measured. Three of the rooms had approximately the same exposure except that they were located on the 7th, 18th, and 27th floors. Previous analyses had indicated that the actual heat requirements of the rooms consisted of the actual heat requirements plus 50% of the estimated solar radiation. In other words, 50% of the solar radiation was effective in heating the rooms. On this basis, that is, allowing for solar radiation, the actual heat requirements expressed as a ratio of the estimated heat requirements indicated that on the lower floors more heat was required than calculated while on the upper floors somewhat less was necessary, the ratio being 102.6, 98.9, and 91.6% for the 7th, 18th, and 27th floors. In other words, the chimney effect of the building resulted in higher infiltration on the lower floors and less infiltration on the upper floors, as compared with estimated infiltration.

The conclusions in these tests regarding solar radiation were that it has a considerable effect on the heat requirements of rooms affected, but that this effect is much less than the total solar radiation impinging against the window, and that a considerable lag exists between the time of maximum solar radiation against the window and its effect on the heat load of the room. The solar effect is, however, a considerable factor in reducing the total heat required in many rooms during the heating season. In other words, it has an important effect on the fuel or heat consumption of a building, but practically none in the design of the system for the building.

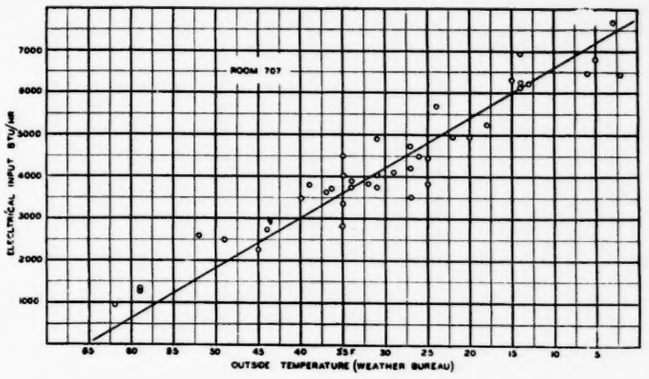


Fig. 2. Relation between outside temperature and electric heat input for a room in the Grant Building, Pittsburgh.

By plotting the amount of heat required for the various rooms against the outside temperature, the outside temperature could be determined above which no heat was required. The drawing in Fig. 2 shows that for at least one room this base temperature was 65F, the figure used in degree-day calculations. However, other rooms carried different bases, some as low as 59F, the latter being the base for rooms having no solar radiation. It should be pointed out, however, that the temperatures against which the heat inputs were plotted are hourly temperatures and not mean temperatures such as used in degree-day calculations. On the other hand, the chimney effect of this building was an important factor affecting these base temperatures. The plotted data show the usually accepted straight line relationship between heating requirements and temperature difference.

It can be concluded then that, taking the factors of exposure, type of construction, infiltration, etc., into account, the heating requirements of a given room still vary considerably. Among the uncontrollable factors is the moisture content of the building structure, difficult to estimate.

The tests show very clearly that it is quite true that there is less variation in fuel consumption or steam consumption in cold weather than in mild weather. When the number of degree-days is less than 20, a wide variation was apparent, whereas a very definite relationship was shown between the amount of steam per hour per degree-day on days of 50 or more degree-days. This substantiates the commonly accepted belief that heating is more efficiently supplied in cold than in mild weather and that the lack of efficiency becomes more pronounced as we approach 65F.

USSR Now Makes Air Conditioning Apparatus

THE first Soviet-made air conditioning apparatus, built by the Leningrad Institute of Labor Protection, has passed its tests and the Institute is planning to install air conditioners in the Skorokhod Shoe Factory and the Dzerzhinsky Textile Mills in the near future.

Air conditioning will be used by the textile, leather, bread-baking, and other industries whose technical processes require maintenance of special atmospheric conditions.

In building the air conditioning apparatus, copper capillary pipes with an inside diameter of 0.3 mm. were made for the first time in the USSR. The pipes, 15 meters long, have an outside diameter of 1 mm. In addition, the Institute had to master production of phosphor-bronze air gauge spiral pipes. These pipes are 0.2 mm. thick.

All the work was carried out by the Institute without foreign consultation, and all parts were made from Soviet materials. The conditioner was designed by D. A. Rosenbaum, an engineer and director of the Laboratory of Air Conditioning.—*Moscow News.*

Air Control for Bituminous Underfeed Stokers

Being Leaves from an Engineer's Notebook, and relating to the different types of air control dampers and regulators.

By NOEL CUNNINGHAM

IN burning bituminous coal in underfeed unit stokers the correct adjustment of air to coal delivery is vital.

In practice approximately fourteen pounds of air must be delivered to the fuel bed for complete combustion of each pound of coal, some coals requiring more and some less. Speaking very generally, coal having a larger proportion of combustible element will require more air than a coal of higher ash content. The chemical composition of the volatile has some effect on the air requirement, and coal low in volatile will require more air than a high volatile coal, as a pound of fixed carbon combines with more oxygen in burning than does the same weight of hydrogen or hydrocarbon.

A common method of maintaining a uniform air supply from a constant speed fan is to keep the discharge pressure from the fan steady. Reducing the back pressure increases air delivery and vice versa.

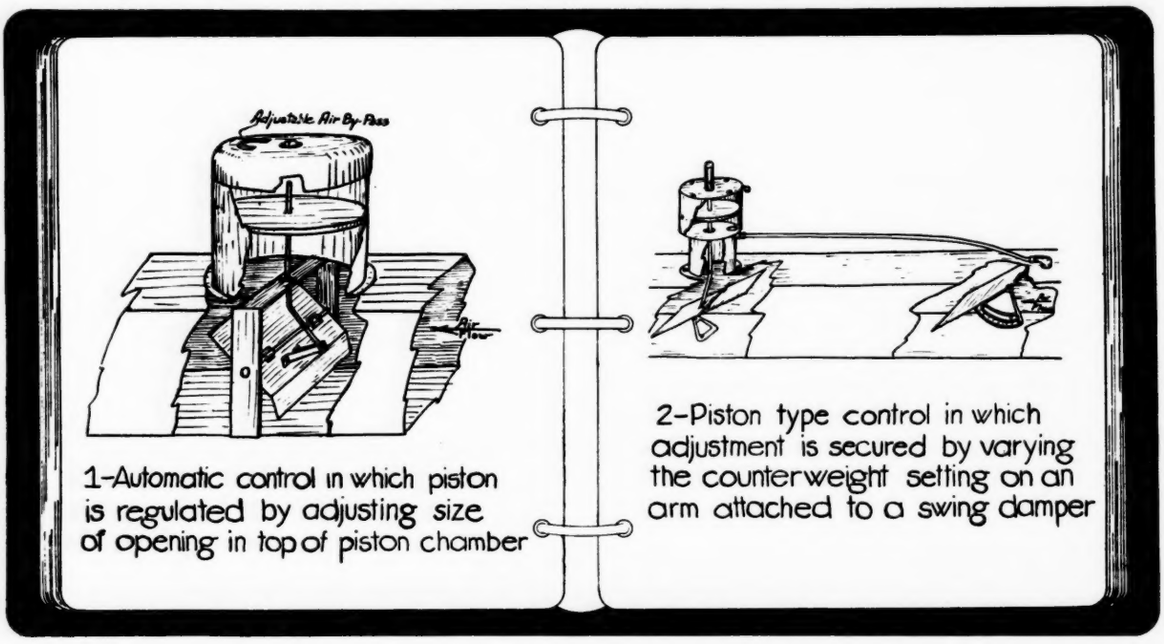
Effects of Operating without Control

Back pressure against a fan delivering air to a stoker through an air duct with no control varies with the thickness or compactness of the fuel bed. If air delivery is too great, the coal in the stoker retort at first burns faster than the rate of the coal feed, the fuel bed thins, the fan pressure drops, the fan delivers still more air and, unless other factors interfere, the fire burns completely out.

Often, when excessive air is delivered, local areas of intense heat are set up and sticky masses form to close the tuyere openings. The excess air condition then reverses itself and the fuel bed builds up, still further increasing pressure against the fan, combustion space within the heater firebox is reduced, gases pass off unconsumed, chilling sets in, and a fuel bed which a short time before was about to burn out becomes choked with fuel.

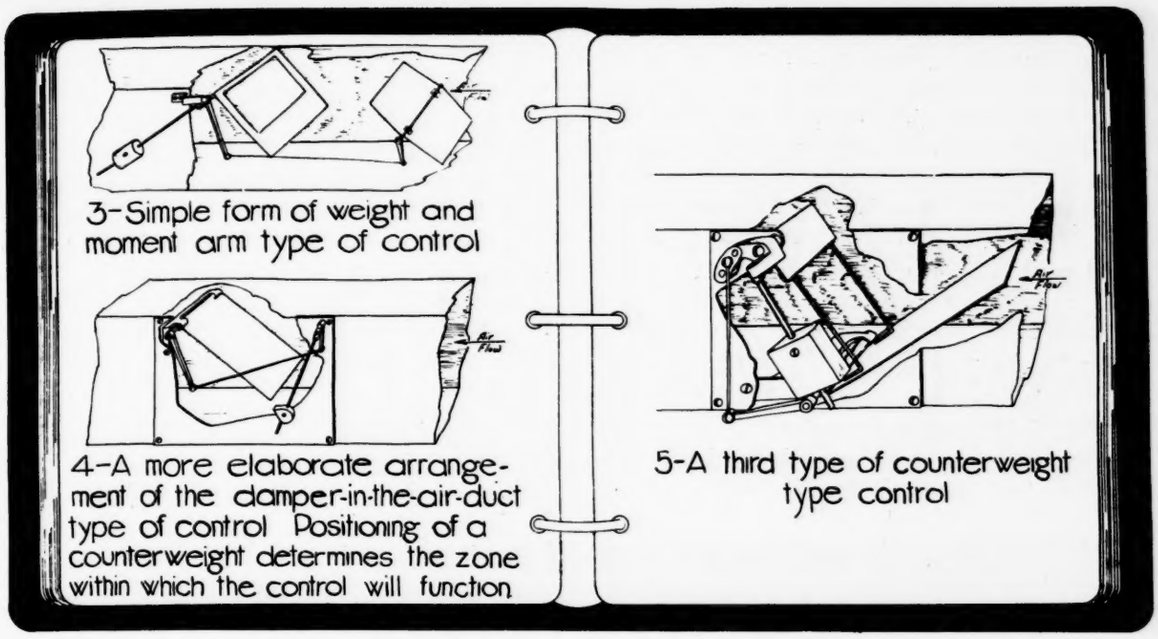
Another difficulty develops when variation in back pressure against the fan is not controlled. All bituminous coal contains a proportion of fine element and this passes through the interstices between larger particles and stratifies at the lowest point it can reach. Thus, the coal charged into a stoker coal hopper is subject to large size variations and the delivery from the hopper is even less uniform than the coal with which it is charged. As the hopper empties, the first portion to pass is more than average dusty. Then, for a time, the material leaving the hopper contains more lump and less dust. As the hopper clears itself, slides high in fine material content come in from the sloping portions of the bottom. Sized or oil-treated coal is less subject to irregularity than untreated screenings, but, to a lesser or greater extent, the stoker fuel bed is normally alternately coarse and fine and, as a result, it is variable as regards air permeability. If the fan delivery is not automatically controlled, the proportion of air input to coal feed fluctuates, periods of coal softening and clinker formation are succeeded by periods of poor combustion and, even if nothing worse develops, heating efficiency is low.

Where normal bituminous coal is being stoker fired at rates not in excess of 6 lb. per hr. per sq. ft. of horizontal internal firebox area (i.e. within the range of ordinary building heating rates), the best results are obtained where the fuel bed back pressure against the fan varies little from ½ in. of water. However, without automatic air delivery regulation, pressures all the way from ⅛ in. to 1¼ in. are not uncommon. An effective automatic control begins to function the in-



1-Automatic control in which piston is regulated by adjusting size of opening in top of piston chamber

2-Piston type control in which adjustment is secured by varying the counterweight setting on an arm attached to a swing damper



3-Simple form of weight and moment arm type of control

4-A more elaborate arrangement of the damper-in-the-air-duct type of control Positioning of a counterweight determines the zone within which the control will function

5-A third type of counterweight type control

stant that fuel bed conditions begin to change. As a charge of dusty element comes into the retort, the automatic control should at once cause the fan to deliver the right proportion of air through the less permeable bed. There is then, during the dust feeding period, a greater back pressure but this over-pressure at once drops back as the texture of the feed returns to normal. Should the excess dust content feed period be followed by one in which the coal is practically dust free, the automatic closes to allow a gentle burning action instead of a blasting condition which would occur were there no automatic control.

At the present time the use of bituminous underfeed coal stokers is increasing and it is probable that this form of stoker is due for a very active period of development. The general design features are well standardized and coal producers are supplying excellent fuel especially prepared for stoker use. Successful automatic air regulation is of tremendous importance and the present devices for location in the fan discharge follow either of two main forms.

One form of control device uses a light piston within a chamber set on top of the air delivery duct from the fan to the stoker. When the stoker is not operating the piston is supported on the bottom of the piston chamber and a butterfly damper within the duct and actuated by the piston is in an entirely closed position thereby acting as a banking damper to restrict natural draft through the fuel bed. As the stoker resumes operation, the piston rises gradually to prevent any initial blasting action, the piston and its connected damper assuming whatever position the then condition of the fuel bed warrants. Air leakage occurs around the piston, this leakage being less if the air permeability of the fuel bed is high and its consequent back pressure low, and greater when there is a less air permeable condition within the fuel bed. The amount of this air leakage determines the position in which the piston will float and the consequent setting of the butterfly damper, the greater the back pressure the higher the piston will ride and the more the damper will open to allow freer fan delivery.

As the stoker continues to operate, the automatic control gradually brings the fuel bed to a condition of normalcy. Thereafter it will react to allow greater or lesser freedom of fan delivery as fuel bed air permeability decreases or increases. Two variations of this kind of automatic control are shown in Figs. 1 and 2. In that illustrated by Fig. 1 the piston and its attached damper are regulated to various zones of action by adjusting by hand the size of an opening provided in the top of the piston chamber. As has been stated, the amount of air required to properly burn coal is variable with different coals and a damper setting suitable for one coal may be incorrect for another; with the form of regulation illustrated, a greater opening in the top of the piston chamber provides for a coal requiring more air while, for one requiring less, the size of the opening is reduced, causing the piston to ride lower and the damper to maintain regulation throughout an area somewhat restricting fan delivery. The same procedure applies to variations in rate of coal feed; the less pounds of coal per hour the stoker is set to deliver, the less will be the opening which controls the piston position.

In the control illustrated in Fig. 2, a constant opening is provided for air leakage past the piston and adjustment is secured by varying the counterweight setting on an arm attached to a swing damper set on the fan side of the piston chamber. A pipe cut into the air duct back of the swing damper connects from there into the bottom of the piston chamber. By weighting the swing damper more or less the piston rides higher or lower in the piston chamber and the fan delivery is controlled through a range of greater or lesser air delivery as the kind of coal or rate of feed may require.

Another similar arrangement has a number of excellent features. A chief difference from Figs. 1 and 2 consists of the provision of a leather diaphragm instead of a piston in a chamber connected to the air duct. This diaphragm actuates a mercury tube in the circuit of the motor operating the coal feed. The fan is driven by its own motor and runs whenever the building and heater controls are calling for heat. The

coal feed is intentionally set for a higher rate than the fan will care for with the result that the fuel bed builds up. When this occurs, back pressure against the fan increases, the diaphragm expands and cuts out the coal feed motor. The fan continues to operate, the fuel bed burns down, the back pressure falls off allowing the diaphragm to contract and open the coal feed motor circuit; the coal is again overfed until the cycle is repeated.

The second general form of control device depends upon various arrangements of weights and moment arms. The oldest and simplest of these is shown in Fig. 3. A top hinged and adjustable counterweighted target damper is placed in the air duct and this actuates a butterfly damper which in turn controls the air delivery from the fan. The rate of flow of air through the air duct being dependent upon the amount of back pressure against which the fan must deliver, the flow begins to fall off when air permeability of the fuel bed begins to increase. The hinged target damper responds, the counterweight elevating it against the decreased air flow; this in turn opens the butterfly damper and allows more air to pass from the fan to the fuel bed. As the condition of unbalance corrects itself the air flow begins to increase, the target damper is consequently depressed and closes back the butterfly damper and reduces air flow to the fuel bed. When air permeability within the fuel bed increases, the action is reversed and the increased air flow causes the target damper to overweigh the counterweight and close the butterfly damper, less air reaches the fuel bed, which builds up back pressure against the fan until the condition of unbalance is rectified.

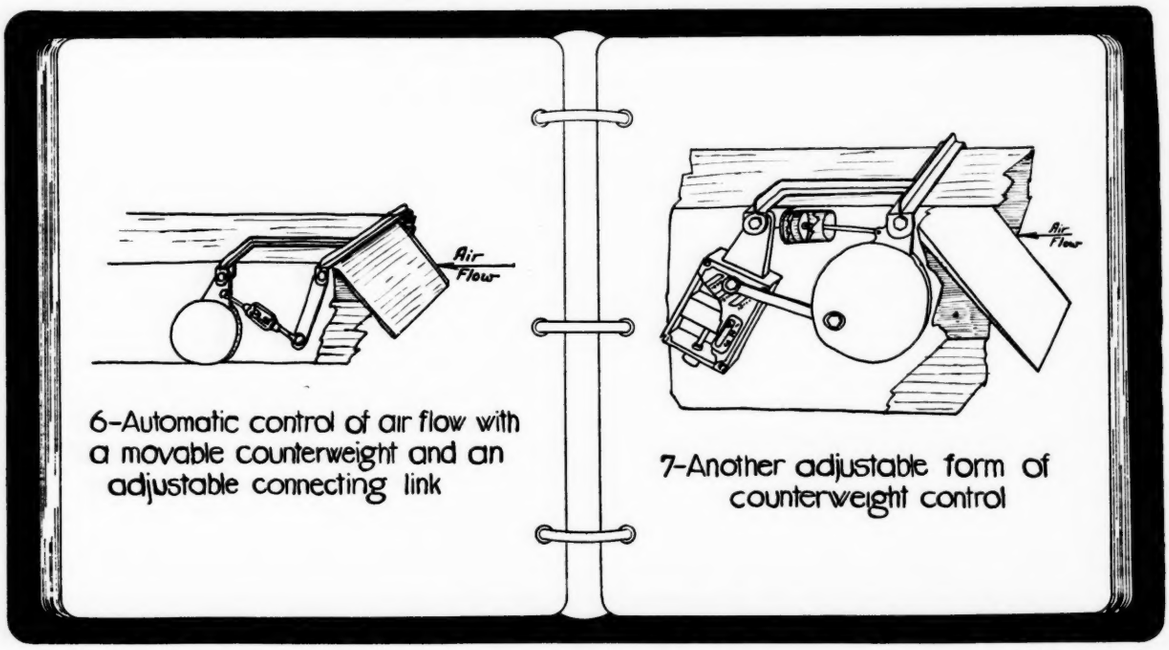
A more elaborate arrangement of damper-in-air-duct is shown in Figs. 4 and 5. This depends upon a nice interaction of air flow pressures against a system of moment arms. The positioning of a counterweight determines the zone within which the control will function. Moving the weight away from the fulcrum of the weight arm provides for air control with larger quantitative air delivery, while moving the weight toward the fulcrum restricts the amount of air, the moment arms controlling in either case the regulation to meet changing fuel bed conditions. The early stages of damper movement are assisted by the moment arms in both the damper and counterweight attachment while, as the damper continues to swing toward a closed position, first the counterweight arm and then the damper arm come into moment positions opposing damper movement. The top hung damper, Fig. 4, is used for stokers having a small rate of coal feed and a low velocity of air passing through the air duct while, for larger size stokers having a high velocity of air flow, the bottom hinged type of damper is used (Fig. 5).

A similar arrangement, Figs. 6 and 7, provides an additional adjustment. The counterweight is movable and also the connecting link from the damper arm to the counterweight arm may be lengthened or shortened. By elongating this link more weight is thrown against the damper and control is effected through a lower range of air delivery and shortening the link provides control over a higher air delivery range.

On the assumption that there is a certain amount of hand adjustment required in setting and resetting the various controls that have been cited, an automatically resetting damper has been recently placed on the market. This damper determines its own proper zone of action by picking up and releasing a series of weights. Having found the range of damper variation suitable to the coal characteristic and rate of coal feed, it maintains regulation without further change until some considerable variation either in the kind of coal used or the coal feed rate necessitates readjustment when it will reweight itself and maintain a proper fuel bed under the new conditions.

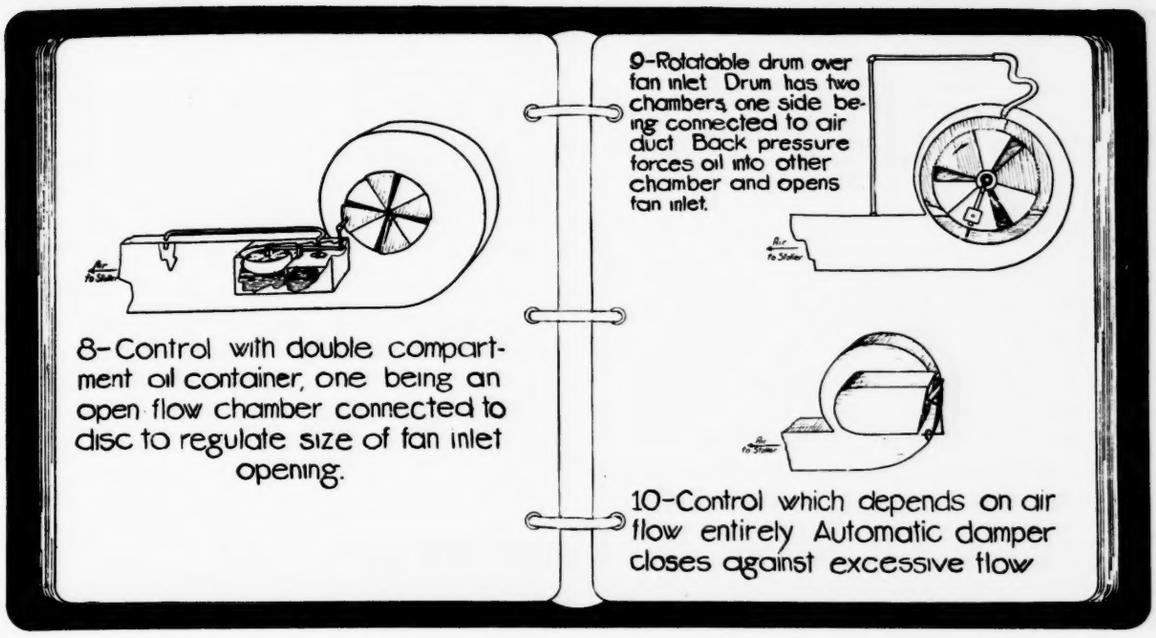
Control at the Fan Inlet

All the foregoing controls are placed between the fan and the stoker and regulate by throttling the air delivery from the fan. In Figs. 8, 9, and 10 are shown arrangements for regulating the area of fan inlet opening according to variations in back pressure within the stoker fuel bed.



6-Automatic control of air flow with a movable counterweight and an adjustable connecting link

7-Another adjustable form of counterweight control


8-Control with double compartment oil container, one being an open flow chamber connected to disc to regulate size of fan inlet opening.
9-Rotatable drum over fan inlet. Drum has two chambers, one side being connected to air duct. Back pressure forces oil into other chamber and opens fan inlet.
10-Control which depends on air flow entirely. Automatic damper closes against excessive flow

The control illustrated in Fig. 8 consists of a double compartment oil container, the two compartments being connected by a small orifice. One of the compartments is a pressure chamber connected by a tube to the fan delivery duct, the other an open float chamber, the float being connected to a disc which can turn so as to regulate the size of the fan inlet opening. As back pressure within the air duct increases due to changing conditions within the fuel bed, the float rides higher and opens up the fan inlet, closing it again as pressure decreases. When the fan is inoperative the oil levels out between the two compartments, the float subsides and closes the fan inlet to banking position.

Fig. 9 illustrates a similar arrangement of fan inlet control. A rotatable drum over the fan inlet is provided with air openings and is counterweighted so as to bank the fan inlet when the stoker is down. The drum is divided into two chambers by a partition through which there is a small connecting orifice. One side of the drum is connected to the air duct and back pressure forces oil through the orifice into the other side causing it to overweight and turn to open the fan inlet proportionally to the back pressure.

Fig. 10 illustrates a fan inlet control which depends entirely upon air flow. When the stoker is inoperative the inlet is wide open. When the stoker is running, air flow is in inverse relation to fuel bed back pressure. The automatic inlet damper closes against excessive air flow and opens when air flow drops off due to building up of fuel bed back pressure.

Any of the controls illustrated will function for a considerable variety of coal characteristics and normally changes in setting are required only if the rate of coal feed is to be changed. There has been a tendency in stoker design to provide for an unnecessary number of coal feed rates for individual stokers used in domestic heating. In larger plants where supervision is provided there is a certain advantage in having two or more rates of feed but, with proper surveying of the usual smaller installations where attention is inexpert and infrequent, there is no adequate reason for changing rates of coal feed. Any ordinary building can be taken care of with a definite number of pounds of coal per hour in both mild and severe weather and there is no excuse for inability to determine the correct rate of coal feed. With the stoker correctly set in this respect, the automatic damper needs little adjustment.

It seems reasonable to expect that the tendency in future smaller stoker design will be away from provision of multiple coal settings which can be readily changed by the stoker user. Any qualified installer should be able accurately to survey a building and heating plant in which a stoker is to be installed. Presupposing an accurate survey, the determination of the correct coal feed rate is a simple matter and this rate of feed should be provided exactly in order to assure realization of maximum economy in operation. This involves direct connection of the power unit to the fan which would run at the proper speed for best efficiency. The connection from the power unit to the coal feed would then logically be through a speed reducing element by belt and pulleys properly sized to give the required rate of coal feed. This involves a considerable saving by eliminating the cost of multiple coal feed rate adjustments. If a portion of this saving is used in elaborating automatic control of air delivery the result is certain to be beneficial to all concerned.

An examination of service call records will show that a large proportion of the present fantastic service costs is due to nothing in the world except out of control air adjustment. Coal producers are spending large sums to provide fuel upon which anywhere from one to three dollars per ton must be loaded simply because heretofore there have been mysterious coal ailments which were due to just one thing, alternate blasting and smothering of stoker fuel beds. Almost any coal will give good results in stokers with the right air adjustment. With automatic air control calibrated to pound per hour feed rates and proper coal feed rate settings it seems certain that costs of equipment, service, and fuel can be materially reduced.

Additional devices will be described in a later issue.

Use of the Degree-Day by the New York Central Building and the Real Estate Board

By C. P. BENNECHE†

New York Central Building, New York.

THE Degree-Day first came to my attention in 1929 in the pages of HEATING & VENTILATING. We adopted the degree-day at the beginning of the heating season of 1929-30 to check our rate of steam consumption in the New York Central Building, 230 Park Ave., New York. This was the first season after the building was completed. One of the things we wanted to satisfy ourselves about was the question of using 65F as the base line from which to figure degree-days. We soon found that this figure was correct for our case, as heat is required when the daily average temperature is below 65F, but not when it is above 65F. We have used the degree-day continuously since that time in setting up our figures for steam consumption for heating, with the result that we now have complete records on this basis for the seven heating seasons from 1929 to 1936, inclusive.

The standard report on outdoor temperatures is that published by the Weather Bureau, but since this report shows a "mean" instead of an "average" temperature for each day we were not satisfied that the number of degree-days arrived at by subtracting this mean temperature from 65 would be accurate enough to be used as a basis for checking steam economy. We did not use this report in the beginning, therefore, but instead plotted hourly temperatures for each day, as shown on the attached chart, Fig. 1. We subtracted the average of these hourly temperatures for 24 hr. from 65F. This gave us an accurate measure of the number of degree-days. This chart, showing as it does the hourly steam consumption as well as the hourly temperature, gave a very accurate picture of what was being done in heating the building.

After using this method from September, 1929, until January, 1934, we discontinued it because it gave comparative information on our own performance for only a week at a time and, since it was based on our own temperature records, was of no use in making comparisons with other buildings. Since that time we have computed degree-days by merely subtracting the mean daily temperature, as reported by the Weather Bureau, from 65F. This is the standard method and is reasonably accurate except when comparing degree-days for a single day. A variation of 2F or 3F between the mean and the average temperature might then be responsible for a large percentage difference in the number of degree-days for such day. The percentage difference is small when considering a longer period such as a week, or a month, or more.

As an illustration of the difference between the mean and the average let us consider the temperature record for Monday, March 13, 1933, as shown in Fig. 1. The mean temperature for this day was 44F, which, subtracted from 65F, indicates a 21 degree-day. This day's steam consumption, of 205,000 lb., divided by 21 gives a rate of steam consumption for this day of 975 lb. of steam per degree-day. But the average tem-

This paper, awarded second prize in HEATING & VENTILATING's DEGREE-DAY COMPETITION, deals with the method developed by the author, and now used by the New York Central Building for checking steam consumption to prevent waste. A chart is described which shows the savings graphically

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perature for this day, obtained by averaging the hourly temperatures, was 41F, which indicates a 24 degree-day. This, divided into 205,000, gives a rate of steam consumption for this day of only 857 lb. of steam per degree-day. This difference between the mean and the average temperature is often smaller but sometimes much larger, and when the total number of degree-days for a day is small introduces a large error.

For the past several seasons we have been plotting our record of steam consumption and degree-days in the New York Central Building as shown on the seasonal chart, Fig. 2. This type of chart seems to me more useful than others that have been used. Each day's performance is plotted as a point on this chart, the degree-days for the day as the abscissa and the pounds of steam consumed as the ordinate. As will be seen from the chart, which shows a point for each day of the entire heating season of 1935-36, this results in a great many points scattered within fairly narrow limits. The variations from a straight line are due to the factors other than outdoor temperature which influence steam consumption. Some of these factors are: high winds, longer hours of occupancy, and days following holidays, which tend to increase steam consumption, as contrasted with strong sun and reduced hours of occupancy which tend to decrease steam consumption. Sundays and holidays are not shown as steam consumption on such days is abnormally low. These would, therefore, destroy the proportionate relation between steam consumption and degree-days for the season.

After the heating season is ended and all points have been plotted the curve representing the entire season's performance is plotted. This curve is added to a new copy of the chart along with the corresponding curves for previous seasons and the chart is then ready to be used for the plotting of points for the ensuing season in the manner described. In the New York Central Building we make up this chart in large size, about 4 ft. x 4 ft., and post it in the engineer's office. Each day the engineer plots a point representing the previous day's performance. The locations of these points in relation to the curves of performance in previous seasons are a constant check for him as to whether his current operation is more or less economical than the past operation has been.

A word here as to the method of plotting the curve representing the entire season's performance may not be amiss. First, the best representative smooth curve is sketched in for all points on the chart. A few points representing the weighted averages of the many are determined and these, substituted for the many points, are used in determining the final curve. One of these weighted average points is plotted for every 5 degree-days from zero to the greatest number of degree-days occurring during the season, which would, of course, be for the coldest day. All the daily points in each group of 5 degree-days are used in determining the point representing the weighted average of the group. For example, in determining the point for 20 degree-days all the points for 2 degree-days each side of 20 are used; that is, all the points for 18, 19, 20, 21, and 22 degree-days. The weighted average (P) of these points may be determined by using the formula (illustrated in Fig. 3).

$$Q_a = A \frac{S-NK}{D} + K$$

where A is the abscissa of point P, measured in degree-days;

N is the number of points in the group;

S is the total steam consumed by N points in the group, measured in pounds;

D is the total number of degree-days for the N points in the group;

K is the ordinate of the point of intersection of the rough curve with the 0 degree-day ordinate measured in pounds of steam;

Q_a is the ordinate of the point P and represents the weighted average of steam consumed for A degree-days, measured in pounds.

This is the value for which the formula must be solved.

Referring to Fig. 2 and applying this formula to the determination of the weighted average 20 degree-day

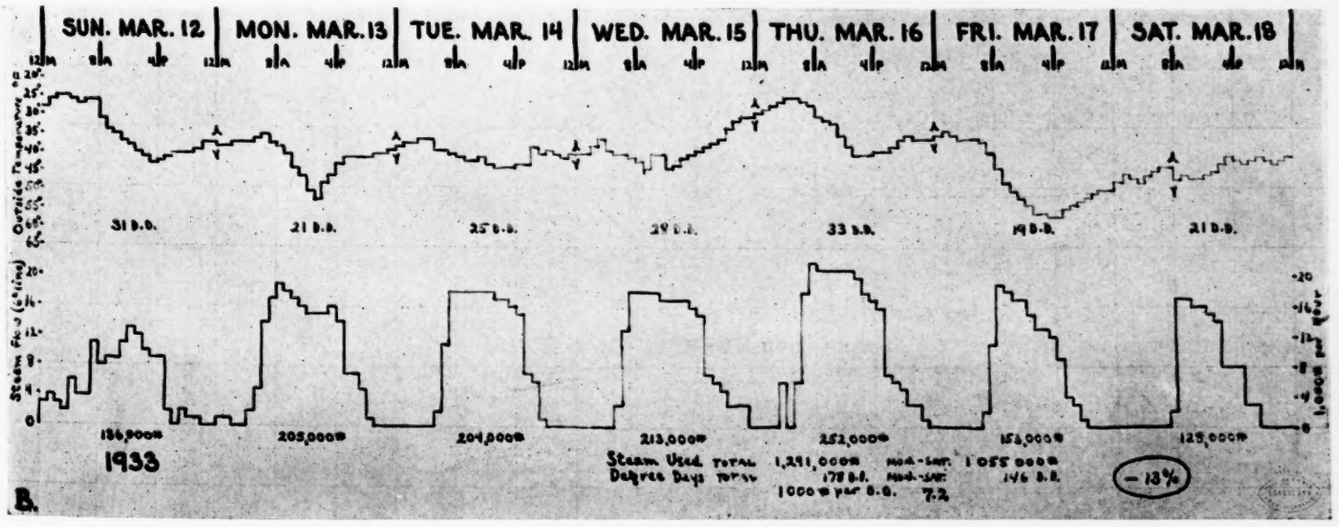

Fig. 1. Chart of degree-days and hourly steam flow originally used by the New York Central Building.

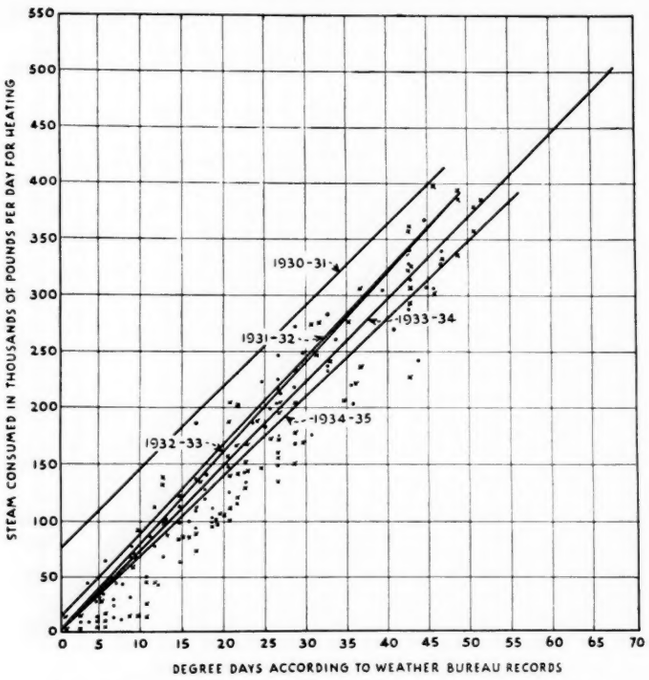

Fig. 2. Chart of degree-days and daily steam consumption now in use by the New York Central Building.

point for the 1935-36 season, we find the values of the symbols in the formula to be:

A = 20 degree days

S = 3,498,000 lb. of steam, determined from Fig. 2 as follows:

DAILY STEAM CONSUMPTION				
18 D.-D. Lb.	19 D.-D. Lb.	20 D.-D. Lb.	21 D.-D. Lb.	22 D.-D. Lb.
120,000	95,000	106,000	101,000	116,000
128,000	98,000	107,000	112,000	121,000
141,000	99,000		113,000	142,000
	100,000		126,000	166,000
	102,000		141,000	201,000
	103,000		147,000	
	111,000		154,000	
			156,000	
			188,000	
			204,000	
Totals				
389,000 +	708,000 +	213,000 + 3,498,000 = S	1,442,000 +	746,000 =

N = 27 points (3 for 18 D.-D., 7 for 19 D.-D., 2 for 20 D.-D., 10 for 21 D.-D., and 5 for 22 D.-D., giving a total of 27)

D = 547 degree-days [(3 x 18) + (7 x 19) + (2 x 20) + (10 x 21) + (5 x 22) = 547]

K = 0

Substituting these values in the formula: $Q_a = A \frac{(S-NK)}{(D)} + K$

we get

$$Q_a = 20 \frac{(3{,}498{,}000 - 0)}{547} + 0$$

Q = 127,900 lb. of steam for 20 D.-D.: weighted average.

Similarly, the point for 5 degree-days is computed by taking the weighted average of all points from 1 degree-day to 7 degree-days, inclusive; the point for 10 degree-days by taking all points from 8 degree-days to 12 degree-days, inclusive, until all points from 5 to 55 degree-days are plotted. The best representative smooth curve, not necessarily a straight line, is then drawn for all these points. This curve represents the season's performance.

As will be observed, the curves as plotted are straight lines and, therefore, have a constant slope, which may be expressed as a certain number of pounds of steam per degree-day and, except for the 1930-31 season, pass very nearly through the zero-zero point of the ordinate and abscissa.

If the curve for the season's performance does not pass through the zero-zero point approximately, as was the case for the 1930-31 season, a correction must be applied to take care of the departure from zero-zero in the computation of the weighted average for each 5 degree-day point. This correction is taken care of by the symbol K in the formula. For the 1930-31 season, K = 80,000 lb. of steam, approximately.

Performance curves which are straight lines and which pass through zero-zero, are attainable only when steam is supplied to the building from an outside source, so that steam flow may be controlled by a valve and, further, when distribution of steam in the heating system is balanced in mild weather as it balances itself naturally in extremely cold weather when all radiators are full. Such performance cannot be attained with an individual boiler plant heating a building since the efficiency of the boilers falls off as the load decreases, nor is it possible even in a building receiving its steam from a central plant unless control and distribution of the steam are accurate. Distribution of steam in mild weather has been balanced in the New York Central Building by installing orifices at all radiators and a very accurate pressure control on the steam main of each heating zone.

It is due to the ingenious device known as the degree-day that it is possible to plot such curves as these to

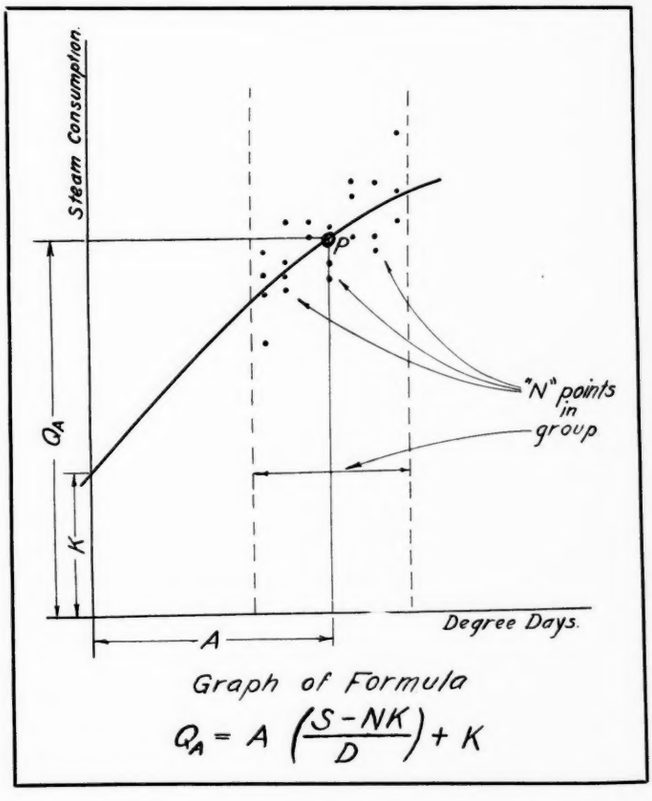

Fig. 3. Illustration of symbols used in the formula by which is determined the position of the point representing the weighted average of all the points in a group.

DEGREE DAYS

APRIL, 1936

Date	This Season - 1936 Mean Temp.	Degree Days	Seasonal Total	Last Season - 1935 Degree Days	Seasonal Total	Normal Season Degree Days	Seasonal Total
W 1	42	23	4712	22	4589	22	4706
T 2	43	22	4734	17	4606	21	4727
F 3	38	27	4761	21	4627	21	4748
S 4	38	27	4788	21	4648	20	4768
S 5	43	22	4810	21	4669	20	4788
M 6	56	9	4819	21	4690	19	4807
T 7	43	22	4841	23	4713	19	4826
W 8	39	26	4867	24	4737	19	4845
T 9	42	23	4890	23	4760	18	4863
F 10	44	21	4911	23	4783	18	4881
S 11	46	19	4930	19	4802	17	4898
S 12	41	24	4954	23	4825	17	4915
M 13	41	24	4978	24	4849	17	4932
T 14	48	17	4995	20	4869	16	4948
W 15	54	11	5006	17	4886	16	4964
T 16	48	17	5023	29	4915	15	4979
F 17	43	22	5045	25	4940	15	4994
S 18	44	21	5066	19	4959	15	5009
S 19	46	19	5085	11	4970	14	5023
M 20	52	13	5098	7	4977	14	5037
T 21	60	5	5103	6	4983	13	5050
W 22	44	21	5124	11	4994	13	5063
T 23	46	19	5143	10	5004	13	5076
F 24	46	19	5162	5	5009	12	5088
S 25	44	21	5183	9	5018	12	5100
S 26	53	12	5195	6	5024	11	5111
M 27	48	17	5212	0	5024	11	5122
T 28	50	15	5227	0	5024	11	5133
W 29	64	1	5228	7	5031	10	5143
T 30	66	0	5228	11	5042	10	5153
Total		539		475		469	

DEFINITION: A mean temperature of 65°F. for a day as reported by the Weather Bureau on its "Monthly Meteorological Summary" is the base line for figuring degree days, as heat is needed in an office building when the temperature is below this, while no heat is needed when the temperature is higher. A daily mean temperature below 65° is subtracted from 65 to determine the number of degree days for that day.
EXAMPLE: Daily mean temperature 15°F. 65 - 15 = 50 degree days.
APPLICATION: Economical heating requires that less steam or fuel be used in mild weather than in cold weather. The use should be in proportion to the number of degree days.

The above was prepared by C. P. Benneche of the Research Committee.

MANAGEMENT DIVISION

THE REAL ESTATE BOARD OF NEW YORK, INC.

Fig. 4. Degree-day report as published monthly by the Real Estate Board of New York.

show directly the relation of outdoor temperature to steam consumption.

An inspection of the curve representing the 1934-35 performance will show that for a 55 degree-day the steam consumption was 385,000 lb., or 7,000 lb. of steam per degree-day. This represents the average rate of steam consumption for the business days of the season. Adding the figures for Sundays and holidays (not shown) the total steam consumption for the season was 33,769,000 lb. Dividing this by the total number of degree-days for the season, 5,270, gives an average of 6,400 lb. of steam per degree-day. For the gross cubical contents of the New York Central Building, 15,350,000 cu. ft., this gives 0.417 lb. of steam per degree-day per 1,000 cu. ft. of building volume. For the 120,000 sq. ft. of radiation in the building we get the figure 0.053 lb. of steam per degree-day per square foot of radiation.

If a building is well constructed and the inside temperature is controlled carefully the number of hours of heating does not affect the steam consumption if the number of hours of occupancy is not changed. In other words, with tenants observing the normal business day from 9 a.m. to 5 p.m., turning steam off at night and turning it on only as few hours as possible during the day may not result in the best economy. It did not prove to be any more economical in the New York Central Building than did keeping the steam on night and day and controlling the temperature with thermostats. This fact is illustrated admirably in Fig. 2. The dots represent the daily performance for the first half of the season and the crosses the performance for the second half. During the first half, steam was turned off at four or five or six o'clock in the evening or later, depending on outside temperature and turned on at four, five, or six the next morning. In the latter half, starting January 10, 1936, steam was not turned off at all, but was kept on the building all night. It was controlled by indoor thermostats to maintain a temperature of 70F at night. At 8 a.m. the control was changed over to a combination of outdoor and indoor thermostats to maintain a temperature of 72F. As will be seen there is no perceptible increase in steam consumption as represented by the crosses as distinguished from the dots. This may be difficult to believe, but it can be explained by stating that air infiltration is reduced to a minimum at night when the building is unoccupied by closing windows and doors. The heating-up load in the morning is eliminated because the wall temperatures in the building have been maintained throughout the night and the air temperature is practically up to that required. The matter of wall temperatures and loss of heat from the body by radiation is a big subject in itself and very interesting, but is not appropriate for the present article.

The research committee of the Real Estate Board of New York, of which I am a member, is composed of technical engineers engaged in real estate operation and, therefore, interested in the correlation of steam consumption for heating their buildings and outdoor temperatures. Many of the members of this committee adopted the degree-day for their own use as soon as they became acquainted with it. This committee decided that it would be helpful to the members of the Management Division of the Real Estate Board if a report were prepared each month showing the number of degree-days during the month. In accordance with this decision the Real Estate Board has been publishing a report of degree-days every month during the heating season since September, 1933.

A copy of this report is shown in Fig. 4. As will be observed, the degree-days for each day of the month as well as the cumulative total each day of degree-days for the season are shown for the Current Season, the Previous Season, and the Normal Season. A comparison of these three seasons shows at a glance everything that an engineer may want to know about comparative temperatures during the month in question. The column that is probably the most useful of all is the "Seasonal Total" for the current season, since the number of degree-days for any fiscal month or other period may be determined by merely subtracting the seasonal total at the beginning of the period from the seasonal total at the end of the period. This total may then be correlated to the steam bill or fuel bill for the period.

This degree-day report is now being distributed by the Real Estate Board to about one hundred and fifty of its members, all of whom have requested it and all of whom undoubtedly make use of it regularly. Another indication of the usefulness of this report is the fact that real estate boards and building managers and owners' associations in a dozen or more cities throughout the country have adopted the idea and now publish a similar report.

WHAT READERS SAY • • •

Boiler Capacity

I want to know a simplified method of estimating the square feet of radiation of a domestic installation, a one- or two-family house, also how to find the capacity of steam boiler.

Brooklyn, N. Y. L. J. W.

We are glad to enclose a copy of our Reference Data Sheet Nos. 33-34. This method of estimating is quite a short cut for residential work and has been quite widely used through the industry.

In connection with your request for a method for finding the capacity of a steam boiler, there is no set rule, so far as we know. The method of selection usually combines the manufacturer's published rating with some kind of check to be sure whether the boiler is of adequate size. The commonest method is to use the square foot of grate area for this purpose. For small coal-fired boilers, fired by hand and using natural draft, it is fairly common practice to assume that with small anthracite coal these boilers will burn from 3 to 5 lb. of coal per square foot of grate area per hour; with large size anthracite they will burn from 6 to 13 lb. per sq. ft. per hr.; while with bituminous coal they will handle from about 10 to 15 lb. per hr. If you assume an efficiency of combustion of, say, 50 to 60% and know the heating value of the coal, you can calculate approximately the size of the grate area which should be installed. If this lines up reasonably with the rating which the manufacturer puts on his boiler, it is considered all right. So far as we know, this is the shortest method in common use, although we think you will see readily enough that it is not especially short. We also are not at all sure that it is always wholly satisfactory.

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Books

Would you kindly ship or recommend a book on air conditioning suitable for an operating engineer. What I want is a book of instruction on the operation and care of air conditioning equipment especially as applied to sound stages in moving picture studios.

Hollywood, Calif. W. O. H.

We do not know of any books on air conditioning written especially from the standpoint of the operating man. Practically all the books on air conditioning are written for the designer, and those which do have some operating data in them still devote a considerable part of their space to design considerations. Perhaps the nearest approach to an operating man's book is one put out by Gernsback Publications, Inc., 99 Hudson St., New York. The name of this book is the "Official Air Conditioning Manual" by L. K. Wright and it sells for $5. It is a loose-leaf book of approximately 350 pages. We should say that this book is split about fifty-fifty between information which would be useful to operating men and design men.

Another possible source is the National Association of Practical & Refrigerating Engineers. This organization has specialized in operating problems for a long time. It is possible that this organization has some books or pamphlets which might be of interest to you and we suggest you get in touch with them at 228 North La Salle St., Chicago.

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Combustion

Have you published any articles on the differences in combustion space required by oil, gas, and coal when burned in domestic furnaces and boilers? Is it a fact that the efficient burning of these various fuels requires differences in the design of boilers and furnaces?

Detroit, Mich. J. S. T.

We do not recall that we have published anything recently on the difference in combustion space required by oil, gas, and coal when burned in domestic furnaces and boilers. It is a fact, however, that the efficient burning of these various fuels requires differences in the design of boilers and furnaces. The reason behind this is fairly easily outlined.

Gas reaches a combustion space having already been gasified into hydrocarbons at the gas plant. Also, the ordinary type of gas burner has a very accurate adjustment device on it for procuring the amount of primary air mixed with the gas. The burner, therefore, delivers not gas, but a mixture of gas and primary air to the combustion space. The result is a Bunsen type flame which burns completely in a very short distance after leaving the burner by picking up the required amount of secondary air almost at once after leaving the burner orifice. Combustion is completed within a distance of two or three inches after the combustible gases leave the burner orifice. At this point the burned gases develop their highest temperatures. The combustion space required is very small and the heat-absorbing surfaces can be placed only a matter of a very few inches away from the burner orifice because, since combustion is already complete, any chilling of the hot flue gases will not stop the combustion, but will, on the contrary, permit the heat from the gases to be readily absorbed. The result is that gas-fired furnaces not only use a very small combustion space, but their heat-absorbing surfaces are placed in almost direct contact with the burners. Thus, the gas-burning boiler or furnace can be built very compact.

Oil leaves the combustion space in the form of finely divided liquid droplets. Ordinarily, just as it reaches the combustion space it is mixed mechanically with a stream of air. Combustion begins to take place, but usually does so in the air in front of the burner or on some kind of refractory material provided for the purpose. During the burning process it is supposed that the liquid oil is changed into gas hydrocarbons, and from that point on the burning is much the same as the burning of gas. However, the burning device is not of the Bunsen type because of the necessity of atomizing the oil. The result is that the combustion is not completed ordinarily for some distance from the nozzle. Therefore, enough combustion space must be allowed to let the burning process be completed before the hot gases strike the cold heat-absorbing surfaces. The typical flame from an oil burner burns with a very much higher temperature than that of a gas flame. This means a high amount of radiant heat from the combustion and a small amount of convection heat, whereas with gas there is a small proportion of radiant heat and a large proportion of convection heat. This is the reason for the shape commonly taken on by oil-burning boilers where as much of the heat-absorbing surface as possible is made to "see" the flame in order to absorb the radiant heat, while there is only a small number of gas passages in the boiler or furnace in order to absorb the relatively small amount of convection heat.

In the case of the coal boiler, distillation of the coal takes place right in the fuel bed itself inside the furnace and gases are formed there. They rise above the fuel bed without having had a chance to be mixed with much air. Consequently, practically all the mixing has to take place right above the fuel bed. This takes both time and space,

(Concluded on page 78)

EDITORIALS

The Degree-Day

For the past eight years HEATING & VENTILATING has published each month a record of the number of degree-days in most of the important cities. So also have we spread other information about this unit and its use. Because of our interest in seeing the unit developed to its highest usefulness we recently inaugurated a competition offering awards for papers describing how this unit is put to work. The response was immediate and unexpectedly enthusiastic. Papers from the contest are appearing now in each issue. Your attention is especially invited to them. More are to follow in coming issues.

The point we want to make, however, is that merely because the competition has closed you should not conclude that nothing new or useful can now be contributed toward the development of the degree-day. Our interest is continuous because we know that you too are naturally interested in helping to make this unit more useful to yourself and to others. Even now we have plans for extending its usefulness and invite the cooperation of all who use this most interesting unit.

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Cooling Results at the Illinois Research Residence

Studies at the Research Residence at Illinois have produced results widely applied in winter heating with warm air. During the past several summers this same residence has been used to study summer cooling using various methods. These results are probably less widely known and less generally applied than those related to heating. On pages 35-42, inclusive, of this issue is an outline of how these summer studies have been conducted and the results which have been produced.

One point is to be particularly noted in connection with these results. The studies really were intended to be studies. The residence was not operated with a family living in it but the equipment was under the supervision of men interested in getting at important facts. What the results would have been if a family had lived in the residence and used commercial equipment for cooling is an interesting question, but is not answered. Interpreted in their true light the results are both interesting and valuable but they may be easily misinterpreted and wrongly used.

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Cooling for Residences

Reports of the amount of cooling equipment put into residences this summer are now becoming available. More installations went into residences than during any preceding year. This shows that progress is being made in the effort to get cooling equipment adopted for residential use. How much progress is not easily determined.

For the first time in recent years this season produced a considerable amount of new residential construction. It offered an opportunity for the builder and owner to give thought to putting in cooling under the best possible circumstances. The ratio of the total number of new residences built to those which provided cooling would give a rough index of the progress made in securing the adoption of cooling in new residences. So far as are known no such figures are available but from what fragmentary data there are it is apparent that such a ratio would be very small. Cooling was not generally accepted for installation in the new residences of 1936.

Still more difficult to determine is the interpretation to be put on this situation for there is little background on which to base a judgment. Almost any desired argument can be developed and apparently supported by the meager facts. The increased number of installations can be hailed with delight by those who are convinced that universal mechanical cooling in residences is on its way. Those who hold the contrary viewpont can readily claim that this failure of cooling to make a better showing is a permanent situation.

Our own point of view is that the showing is really one of progress and that, everything considered, cooling for residences enjoyed all the increase in public acceptance this summer that it has any right to expect. We have always believed that use of complete cooling equipment in residences will come about both slowly and selectively. We do not believe that the buyer of small houses built to sell at a price is now eagerly waiting to get an elaborate cooling equipment included in it. Much of the new residential construction of this summer was strictly price-built. Failure to include full cooling equipment in such construction is neither surprising nor need it be discouraging. The very fact that at least some provision was often made for cooling represents an advance in acceptance of the idea.

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Prevention is Solution of Industrial Dust Problems

During August, a six-day meeting devoted to "The Environment and its Effect on Man" was held at Harvard University as a part of its 300-year celebration. The program assigned a full day to discussion of dust diseases including their causes and their control. No doubt so large an amount of time was assigned because of the thought that dust diseases are important in man's environment.

One of the speakers, Dr. W. Irving Clark, asserted that a half million men are daily exposed to the danger of silicosis. This estimate probably does not state fully the extent of the dust problem as a whole. If a half million men are exposed to sand or quartz dust alone, how many must be exposed to dust hazards from other sources, such as wood dust and textile fiber in the air? Then, too, there are dust hazards which occur in places other than factories and mines. When the full extent of the dust menace is finally found it may run into numbers way beyond those now assigned. Thus, it appears that assignment of one day out of six to this subject was not too much.

All the time and attention devoted to dust and dust control are gradually serving to focus attention upon the problem. At present this attention is being directed especially at silicosis as an industrial disease. That is where pressure for a solution and for a better knowledge of the facts is most urgently desired. There is little doubt though that the whole problem of dust in air will shortly be attacked in earnest. All of us should encourage such attacks for there is every reason to believe that continued study will merely serve to reenforce the conclusion that prevention is the logical method of keeping dust from becoming a menace when it gets into air to be breathed by humans. Ventilation, filtering, and washing are now known and recognized as means for controlling dust concentrations. The present trouble is that they are used all too seldom for that purpose. Once the extent and seriousness of the industrial dust problem is more firmly established and publicized, these methods will do their share in its solution.

GETTING DOWN TO FUNDAMENTALS

Part 16—Heat Quantities from Hot or Cold Pipes, Ducts, Tanks, and Similar Surfaces

FREQUENTLY, the size and capacity of equipment are affected by heat which passes to or from pipes, ducts, tanks, and similar surfaces. Where this occurs it is often essential that the magnitude of these heat quantities be found with reasonable accuracy. It is appropriate, therefore, that the fundamental data for preparing such estimates be examined.

If a pipe or other surface is hotter than the air or other objects around it, heat will leave the hot surface and pass to any colder substances. So, also, if the pipe is colder than the surroundings, heat will flow from the surroundings to the pipe. Our object is to examine the means available for finding out how much heat is involved in this process.

Both processes are of importance for it is frequently characteristic of pipes and similar surfaces in heated or cooled rooms that their function requires that they be kept at a fixed temperature for considerable periods and these periods are likely to cover the time when the heating or cooling plant is operating at peak capacity.

The problem of finding how much heat is involved in these circumstances has received a good deal of attention. As a result the processes whereby the heat is transferred have been analyzed and examined. Not only are the fundamentals of the problem known but studies have brought in a considerable amount of data which are available for the use of estimators.

It is agreed that in the case of either hot or cold surfaces the heat is transferred by the processes of convection and radiation. All of it in most cases eventually reaches the surrounding air or is drawn from the surrounding air. It seems unnecessary to go into a discussion of the details of how the transfer is accomplished or to state the full reasoning which leads to the conclusion. For practical purposes the heat quantities involved can be estimated if the heat transferred to or from the surface by these two methods can be found and totalled. The total is considered as all being added to the surrounding room air or all being extracted from the surrounding room air. The problem of estimating quantities is thus reduced to that of finding ways of calculating the radiated and convected heat.

Radiated heat can be calculated by the long established formula of Stefan-Boltzmann which makes the heat transferred depend on the differences of the fourth powers of two temperatures. As usually stated the formula is burdensome to use. However, there is little help for this. The formula is:

$$H_r = 0.1723 \times e \left(\frac{T_1}{100}\right)^4 - \left(\frac{T_2}{100}\right)^4 \qquad (1)$$

in which H_r = radiated heat transferred in B.t.u. sq. ft. per hr.,
T_1 = absolute temperature of warmer body,
T_2 = absolute temperature of colder body,
e = the effective emissivity of both the bodies.

Values for e must be available before the formula can be used. At temperatures in the vicinity of those frequently encountered in estimating quantities of heat for purposes of this article the values of e for many types of surfaces have been found. Thus Heilman gives values of e as shown in Table A.

TABLE A

	Temperature	
	100F	400F
Galvanized Iron		
Bright	0.44	0.17
Tarnished	0.53	0.53
Copper		
Bright	0.07	0.11
Tarnished	0.43	0.48
Aluminum Foil	0.06	—

Other investigations have reported values of e for other surfaces but there is a fair agreement that for rough, unpolished, dark-colored surfaces the value is in the neighborhood of 0.90, while for polished, light-colored surfaces the value is in the neighborhood of 0.10. At any rate there are values for e in existence which permit the formula to be used.

A point which does not seem clear to many, however, is that the values of e as reported by investigation and as listed in Table A are not always suitable for use at once in the formula (1). It should be noted that the e in the formula is defined as the "effective emissivity of *both* bodies" concerned in the heat transfer. Where the "effective" emissivity of both bodies is the same as that of the hot body then e from the table can be used at once. Fortunately, in the case of most pipes carrying hot or cold substances through the air of an ordinary room this condition prevails and the radiation heat for this condition is closely estimated by using e equal to 0.90 to 0.94. Where large ducts carry air through a small room, however, this condition probably does not prevail and in such cases the results obtained by using formula (1) may be greatly in error if a wrong selection of the value of e is made.

Convection heat, due to natural, or free, flow of air over pipe surface can be calculated by a formula not so well known as the one for radiation heat. In this formula, often referred to as the Rice-Heilman equation, the convection heat depends on the shape and dimension of the solid surface and in the temperature of the air and the solid. The equation is:

$$H_c = C \left(\frac{1}{D}\right)^{0.2} \left(\frac{1}{T_{av}}\right)^{0.181} (t_s - t_a)^{1.266} \qquad (2)$$

TABLE 1

HEAT ADDED TO STILL AIR AT 70° BY HOT PIPE WITHOUT PIPE COVERING

Nominal Pipe Diam. (Inches)	Temperature of Hot Substance (Usually Steam or Hot Water) in Pipe															
	100°		120°		150°		180°		210°		240°		270°		300°	
	Iron and Steel	Copper Tubing	Iron and Steel	Copper Tubing	Iron and Steel	Copper Tubing	Iron and Steel	Copper Tubing	Iron and Steel	Copper Tubing	Iron and Steel	Copper Tubing	Iron and Steel	Copper Tubing	Iron and Steel	Copper Tubing
½	14.5	8.5	25.0	14.9	41.9	25.6	61.5	37.8	83.4	51.5	151.8	65.5	134.0	81.5	163.0	98.5
¾	17.5	11.2	30.0	19.8	51.2	33.9	75.4	50.0	102.5	68.0	132.0	87.1	164.0	108.0	200.0	131.0
1	22.0	14.2	37.4	24.8	63.5	42.5	94.0	62.8	127.0	84.8	163.0	108.8	202.0	135.5	248.0	164.0
1¼	27.0	17.0	46.0	29.6	78.0	50.8	114.0	74.5	158.0	101.5	200.0	130.5	249.0	161.0	304.0	196.0
1½	31.0	19.8	52.2	34.3	88.4	58.8	129.0	86.4	176.0	117.5	228.0	156.0	284.0	187.0	344.0	228.0
2	38.0	25.4	64.2	44.2	108.0	74.1	159.0	111.2	208.0	150.0	277.0	190.5	347.0	241.0	423.0	292.0
2½	45.0	30.6	76.5	52.8	129.0	90.5	189.0	134.0	257.0	180.0	332.0	232.0	414.0	288.0	505.0	350.0
3	54.0	35.9	92.0	63.0	155.0	106.0	228.0	156.0	306.0	211.0	399.0	272.0	500.0	338.0	606.0	411.0
3½	61.0	41.0	104.0	71.0	175.0	121.0	256.0	178.0	339.0	242.0	450.0	311.0	566.0	386.0	685.0	497.0
4	69.0	46.2	116.0	79.5	196.0	131.0	286.0	199.7	394.0	271.0	502.0	349.0	625.0	432.0	765.0	526.0
5	83.0	56.3	141.0	96.5	237.0	165.0	348.0	242.0	474.0	329.0	611.0	424.0	762.0	525.0	932.0	640.0
6	98.0	66.5	166.0	114.0	280.0	195.0	412.0	286.0	557.0	389.0	720.0	500.0	890.0	623.0	1095.0	759.0
8	127.0	—	213.0	—	358.0	—	524.0	—	712.0	—	918.0	—	1148.0	—	1400.0	—
10	156.0	—	262.0	—	440.0	—	648.0	—	875.0	—	1128.0	—	1410.0	—	1728.0	—
12	185.0	—	307.0	—	523.0	—	755.0	—	1020.0	—	1327.0	—	1652.0	—	2020.0	—

Figures are B.t.u. per hour per linear foot.

Dimensions of Standard Iron and Steel Pipe				Dimensions of Copper Tubing			
Nominal Pipe Diam. (Inches)	Outside Diam. (Inches)	Sq. Ft. Area Per Linear Foot (Outside)	Nominal Pipe Diam. (Inches)	Outside Diam. (Inches)	Sq. Ft. Area Per Linear Foot (Outside)	Nominal Pipe Diam. (Inches)	Outside Diam. (Inches)	Sq. Ft. Area Per Linear Foot (Outside)
½	0.840	0.22	3½	4.00	1.047	½	0.625	0.166	2½	2.625	0.687
¾	1.050	0.275	4	4.50	1.178	¾	0.875	0.229	3	3.125	0.82
1	1.315	0.344	4½	5.00	1.306	1	1.125	0.295	3½	3.625	0.95
1¼	1.660	0.435	5	5.563	1.455	1¼	1.375	0.360	4	4.125	1.08
1½	1.900	0.498	6	6.625	1.734	1½	1.625	0.425	5	5.125	1.34
2	2.375	0.622	8	8.625	2.257	2	2.125	0.562	6	6.125	1.61
2½	2.875	0.753	10	10.75	2.818						
3	3.50	0.917	12	12.75	3.338						

in which H_c = convection heat transferred, B.t.u. per sq. ft. per hr.,

C = a constant whose value depends on the shape of the solid. For a horizontal cylinder such as pipe, $C = 1.016$; for a vertical plate, $C = 1.394$; for horizontal plates warmer than the surrounding air and facing upward, $C = 1.79$; for such a plate facing downward, $C = 0.89$,

D = diameter of pipe or circular duct, in.,

T_{av} = average temperature of solid surface and surrounding air, F.

T_s = temperature of surface of solid,

T_a = temperature of surrounding air.

For everyday use this formula also has the disadvantage of being laborious. The calculation can be simplified to a considerable extent by tabulation but even with this help the formula appears rather formidable.

However, from the standpoint of a consideration of the fundamental data available the formula is useful and when proper selection of values of *C* and *D* is made it yields results having a sufficiently high degree of accuracy to justify considerable effort being spent in making detailed calculations.

TABLE 2

HEAT ADDED TO STILL AIR AT 70° BY HOT PIPES COVERED WITH PIPE INSULATION OF THICKNESS COMMONLY USED

Nominal Pipe Diam. (Inches)	Temperature of Hot Substance (Usually Steam or Hot Water) in Pipe															
	100°		120°		150°		180°		210°		240°		270°		300°	
	85% Magnesia	4-Ply Corr. Asb.	85% Magnesia	4-Ply Corr. Asb.	85% Magnesia	4-Ply Corr. Asb.	85% Magnesia	4-Ply Corr. Asp	85% Magnesia	4-Ply Corr. Asb.	85% Magnesia	4-Ply Corr. Asb.	85% Magnesia	4-Ply Corr. Asb.	85% Magnesia	4-Ply Corr. Asb
½	4.9	5.8	8.2	9.8	13.2	16.2	18.5	23.0	23.8	30.2	29.4	37.6	34.8	45.7	40.5	53.8
¾	5.5	6.5	9.2	11.0	15.0	18.2	20.8	26.0	26.7	34.0	33.0	42.5	39.3	51.6	45.6	60.8
1	6.3	7.4	10.5	12.6	17.1	20.2	23.7	29.6	30.6	38.7	39.0	48.3	45.4	58.9	51.9	69.4
1¼	7.2	8.6	12.2	14.6	19.8	24.1	27.6	34.2	35.6	45.0	43.8	56.0	51.2	68.2	60.6	80.5
1½	7.9	9.3	13.2	15.8	21.0	26.2	30.0	37.1	38.6	48.7	47.5	60.8	56.4	74.0	65.4	87.3
2	9.2	10.8	15.6	18.5	25.2	30.6	35.2	43.5	45.2	57.0	55.5	71.5	66.2	87.0	77.0	102.5
2½	10.6	12.5	17.8	21.3	29.0	35.2	40.3	50.2	52.0	65.8	64.0	82.0	76.2	99.7	88.5	117.5
3	12.4	14.6	20.8	24.9	33.7	41.2	47.0	53.5	61.0	76.9	75.0	96.0	89.2	116.5	103.5	137.1
3½	13.7	16.2	23.1	27.6	37.4	47.7	52.0	64.6	67.1	84.7	82.5	103.5	96.0	127.8	109.5	152.0
4	15.8	17.7	25.2	30.2	41.0	50.0	57.1	71.0	73.5	93.2	90.5	116.0	107.7	141.5	125.0	167.0
5	17.8	20.9	31.0	38.2	48.5	59.0	67.5	83.7	86.6	109.8	107.0	137.0	97.0	135.0	112.0	150.0
6	20.7	24.4	34.8	41.7	56.5	69.0	78.8	97.5	102.0	128.5	125.0	161.0	112.5	147.0	131.0	174.0
8	26.0	30.6	43.5	52.0	70.5	86.0	98.5	122.5	128.0	160.5	156.0	200.0	138.0	181.0	161.0	215.0
10	31.4	36.8	52.8	62.8	85.5	104.0	119.0	147.1	154.0	193.2	189.0	242.0	166.0	216.2	193.0	256.2
12	36.8	43.0	62.0	73.5	100.0	122.0	137.5	172.5	179.0	226.0	221.0	284.0	194.0	254.0	223.0	300.0

Figures are B.t.u. per hour per linear foot of Standard Pipe. Insulation is one inch thickness, except for temperatures of 270° and 300° with pipe sizes of 5" to 12", where it is 1½" thick. Table is computed for horizontal pipe but may be used for estimating purposes if pipe is installed vertical.

Thickness of Pipe Insulation Commonly Used on Hot Pipes Indoors.

One Inch Thickness on all pipe sizes with temperature from 100° to 267° (25 lb. gage pressure, steam).

One and One-Half Inches on pipes 4" or larger at temperatures of 267° to 338° (25 to 100 lb. steam), but one inch thick on pipes smaller than 4" at these temperatures.

For Pipe Insulations Not Listed in the Table, Multiply the Tabular Figure for 4-Ply per Inch Asbestos by the Following:

Type Insulation	Temperature of Hot Substance							
	100°	120°	150°	180°	210°	240°	270°	300°
Corrugated Asbestos Eight Ply per Inch	0.905	0.90	0.89	0.88	0.875	0.87	0.865	0.86
Laminated Asbestos 30 to 40 Laminations per Inch...	0.685	0.68	0.675	0.67	0.665	0.66	0.655	0.65
20 Laminations per Inch	1.03	1.02	1.01	0.99	0.98	0.97	0.955	0.94
Rock Wool	0.72	0.71	0.70	0.695	0.69	0.685	0.68	0.67

It will thus be seen that with these two formulas and with the amount of work which has been done in evaluating the factors used in them, calculations can be made which will produce reasonable estimates of the amounts of heat which are involved when tanks, pipes, ducts, and similar hot or cold surfaces are exposed to room air. However, the fundamental data cannot yet be said to be in fully satisfactory condition for there are still cases where there is doubt as to how to select suitable values for use in the formulas.

Examination of data prepared for everyday use shows that certain of the cases where hot or cold surfaces are exposed to room air have been examined much more closely than others. Attention is now turned to some of these cases.

Pipes carrying low-pressure steam or hot water through the rooms of buildings are of such common occurrence in practice and the amount of heat which may be involved is so large that a very great deal of study has been given to this particular phase of the subject.

There are two general cases which are of interest, viz: where the pipe is uncovered and where it is lagged with some kind of heat insulation material. Also there are two general kinds of standard pipe used, viz: those which are made to iron and steel pipe dimensions and copper tubing which has dimensions considerably different from those of iron and steel pipes.

Tables 1 and 2 give values of the heat transferred to still air at 70F by such pipes when they are uncovered and also when heat insulation has been applied to them. Both these tables were computed from formulas (1) and (2) and illustrate well how useful these formulas can be made when applied and with calculations fully complete from them. In both tables the heat quantity is shown per foot of pipe length. Both are shown for the air at 70F but can be used for estimating purposes for from 60F to 80F without serious errors in most cases. In Table 2 multiplying factors are shown which permit estimates being made for nearly all of the pipe insulations in common use.

To cover the cases when cold substances such as water, brine, and refrigerants flow through pipes in still air much less study has been given and, consequently, while it appears that formulas (1) and (2) would be used, there is less assurance on the point. At any rate reasonably close estimates would be fairly certain to result, but no tables similar to those given for hot pipes are known to be in existence. As a result the estimator has to solve the equation each time he wishes to find the heat quantity. This can be done by using a value of 0.90 to 0.94 for e for iron and steel pipes, and of 0.57 for copper tubing in formula (1), and a value of C of 1.016 in formula (2). It is to be noted in passing that the heat per linear foot added to cold pipes from the air is usually not a large amount except where the pipe is uncovered or where the substance in the pipe is at a temperature very much less than that of the surrounding air. For small diameter pipes carrying only moderately low temperature substances through the ordinary room air the amount of heat involved is usually small.

Similarly, there seem to be no pre-calculated tables for cubical or cylindrical tanks either bare or covered with heat insulating material. Estimates can be made from formulas (1) and (2) as needed.

In the case of nearly all hot surfaces there are various tables and estimates which can be referred to but their source is not definitely known in certain cases nor is it always clear as to whether the values are from calculation or from experiment.

Where sheet metal ducts carry either hot or cold air through room air at ordinary temperatures the heat quantities may be estimated by applying formulas (1) and (2) as necessary. Care must be taken in evaluating C in formula (2). There is some evidence that for ordinary rectangular ducts C should be fixed at 1.394.

Thus it is apparent that while the heat quantities due to pipes, ducts, tanks, and similar surfaces can be estimated if necessary this process usually involves laborious calculations except in the case of hot pipes.

Large Central Heating Network Planned for European Capital

A GENERAL plan for the installation of central heating mains in Moscow, a step which will require the expenditure of millions of rubles, is scheduled to be taken up by the Chief Administration of the Power Industry, according to the *Moscow News*.

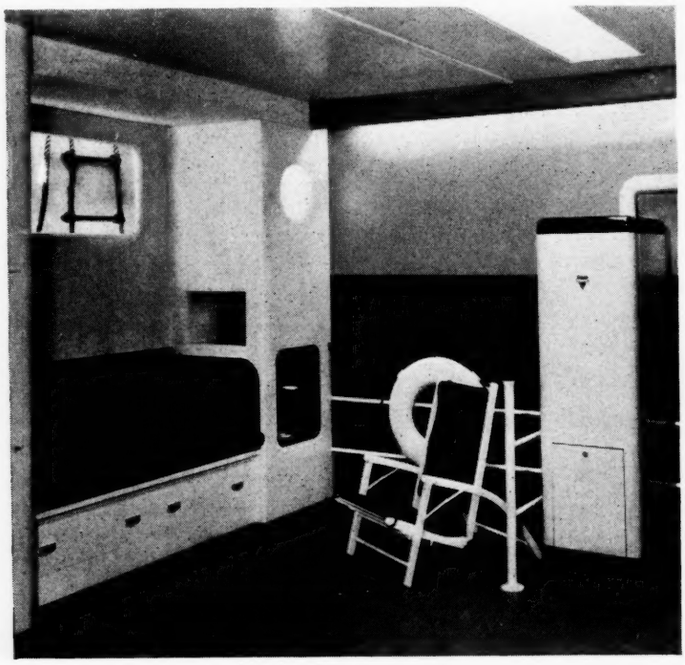
For the purposes of providing heat through a network covering the entire city, the plan will require the erection of several power stations of 3.5 million kilowatt capacity and will involve a total expenditure of about 4,000 million rubles.

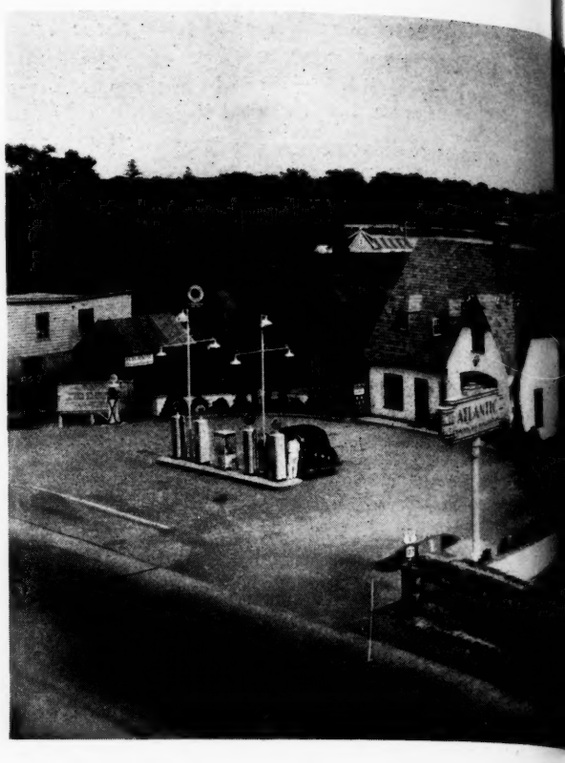
A number of industrial constructions in the Union are to be supplied this year with central heating systems by the Central Network of Heating Enterprises. Estimated value of the work to be carried out this year by this administration, which is planning extensive work on enterprises not yet fully completed, is put down at 20 million rubles. Its mains will extend for a distance of about 400 kilometers.

Another network near completion is located in the Akrekhin Plant, near Moscow. Here a system 3.5 kilometers in length will supply all the shops of the plant.

Among other industrial centers to be provided with central heating installations in the near future are the Nizhni Tagil Car-Building Trust, the Kama Cellulose Paper Combinat, and the Kremerov Chemical Combinat.

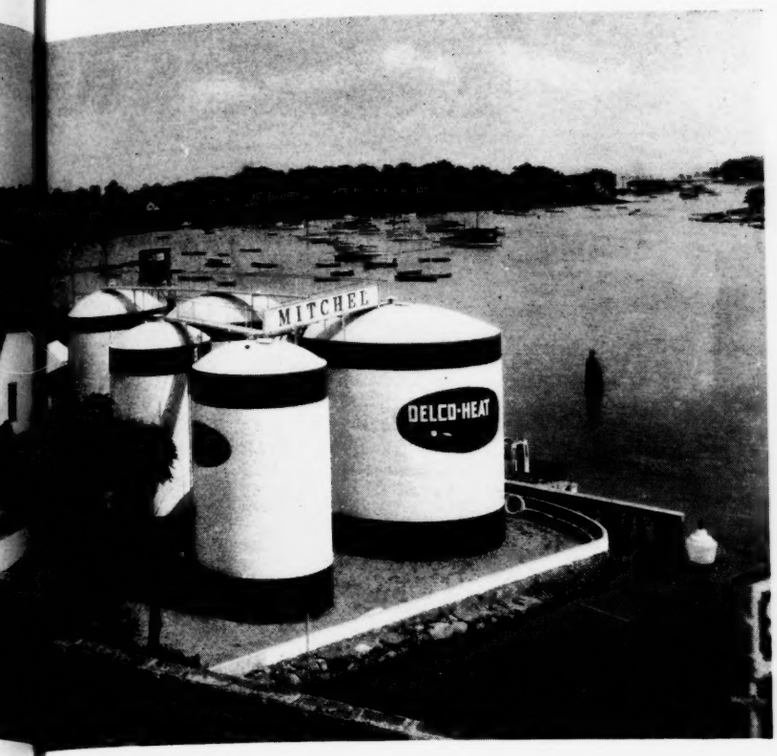
NAUTICAL BASEMENT in blue and white opened to the public at the gas heating and air conditioning show of The Peoples Gas Light and Coke Co., Chicago. The basement is complete with portholes, steamer chairs, bunk seat, and a window through which a variety of watercraft is realistically pictured lying at anchor. Modern heating equipment is designed in harmony with the decorations.





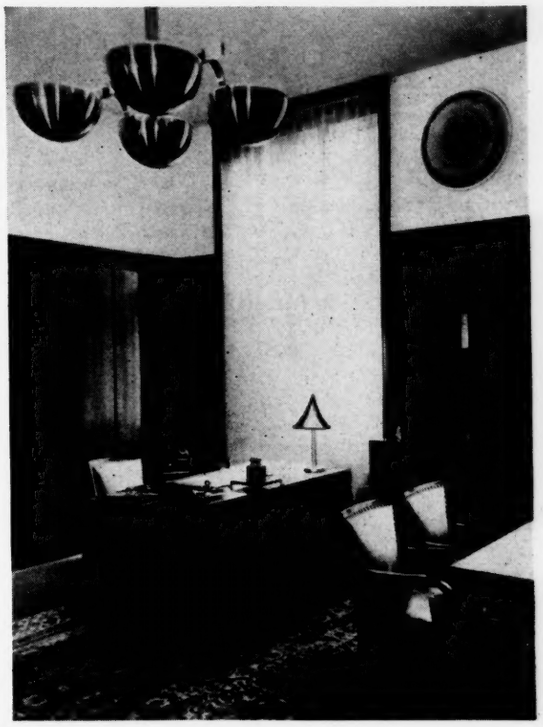
PICTURE

LARGEST HOTEL GOES AIR CONDITIONED. The Stevens Hotel in Chicago now provides air cooled comfort for assemblies to a total of 6,200 guests. Above, Willis H. Carrier officially puts the system into operation. Left, watching the ceremony are, left to right, Scott S. Smith, president, Critchfield & Co.; J. M. Sullivan, Chicago manager, and J. L. Grimes, general advertising manager, Wheeling Steel Corp.; E. P. Heckle, vice-president, Carrier Engineering Corp.; R. B. Hayward, president, R. B. Hayward Co.; O. I. Strickland, manager, tubular sales, Wheeling Sales Corp.; J. C. Hines, R. B. Hayward Co.; E. F. Murphy, vice-president, Carrier Engineering Corp.; Wm. H. Krahl, vice-president and director, Stevens Hotel Corp.; J. L. Neudoerfer, vice-president, Wheeling Steel Corp.; Rufus C. Dawes, president, Stevens Hotel Corp.; Willis H. Carrier, chairman of the board, Carrier Engineering Corp.; W. W. Bird, chief engineer, and Otto K. Eitel, managing director, Stevens Hotel Corp.

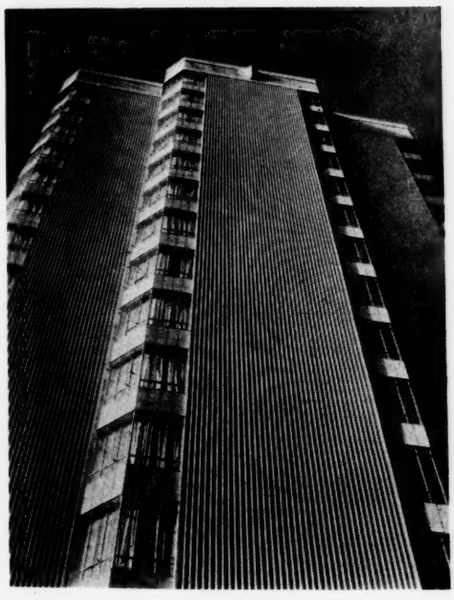


AIR CONDITIONED SERVICE STATION. (Left) This modern service station and oil terminal of the Mitchel Oil Corp. of New York, located at Mamaroneck, N. Y., is not only air conditioned but the company also sells air conditioning units and oil burners. The plant is painted in black and white in keeping with the surrounding landscape of the richest county in the country. Traffic past the station, located on the Boston Post Road, averages 3200 cars per hr.

PARAGRAPHS



UNUSUAL AIR INLET, upper right, is employed to distribute conditioned air in one of the private offices in the Escompto Bank, Prague, Czecho-Slovakia. This bank, one of the largest in Czecho-Slovakia, is housed in a completely air conditioned, modern building.



STUDY IN VERTICAL LINES. The Edmond Meany Hotel, Seattle, has 12 in. solid concrete walls with interior plaster applied directly to the walls without furring. Although the heat loss coefficient is high, 0.50, no condensation has appeared on the walls due to the carefulness with which the heating and ventilating system was designed. The high heat loss was believed to be offset by the structural advantages of the wall. Photo courtesy Portland Cement Association.

CODE MAKERS. Members of the committee compiling codes for the National Warm Air Heating and Air Conditioning Association, especially for furnace installation and changes, at a meeting July 31 and August 1 at Purdue University to consider changes in the codes. Left to right, around the table: B. F. McLouth, Dail Steel Products Co.; Prof. A. P. Kratz, University of Illinois; Fred R. Bishop, Brundage Co. and American Air Filter Co.; Jack Stowell, Robinson Furnace Co.; W. D. Redrup, Majestic Furnace Co.; J. E. Maynard, Fox Furnace Co.; L. N. Smoot, Holland Furnace Co.; E. B. Langenberg, Langenberg Heating Co.; Prof. J. D. Hoffman, Purdue University, chairman of the committee.

ABSTRACTS of Current Papers, Books and Pamphlets

Industrial Dust

The control of dust in industry is a subject of increasing importance to ventilation engineers. The development of new machines and processes has unfortunately resulted in increasing danger for workers because of a large amount of dust and fumes evolved. In the beginning only a small amount of attention was paid to the removal of these hazards but now, due to the increasing danger and the large number of deaths which have occurred, the various state legislatures have passed laws to protect workers. These laws have forced the installation of large and sometimes complicated systems of ventilation to reduce the dust concentration to harmless levels.

The design of such systems requires a considerable knowledge of not only the physical and chemical properties of dust but also a knowledge of the effects of these dusts on human beings. In other words, if the designer is to create an efficient system he must not only be acquainted with the engineering aspects of the problem but also with the medical aspects.

To fulfill the engineer's need for a knowledge of how the hygienic requirements affect engineering designs of dust control equipment, this book has been written. So far as possible only basic principles are considered.

The authors are especially qualified to write a book of this type. Both have served on numerous national committees appointed to consider various problems of industrial hygiene and have also acted as consultants in the investigation of industrial dust problems and in the development and design of dust control equipment. They have contributed extensively to the methods of dust analysis and have published numerous articles on industrial dust.

The subject is treated in an excellent manner, being arranged in a logical order and avoiding as far as possible the use of highly technical terms.

The subject matter in the book may be divided into three sections. The first section gives the various fundamental material necessary to the engineer who designs the dust control systems. Included in this section are discussions on the physical properties of dust, fumes, and mists; the effects of dust and fumes upon man and the physical and chemical factors in pneumoconiosis. The chapter on the effects of dust and fumes on man is one of the most interesting in the entire book and should be read by all engineers interested in dust control.

The second section discusses methods of making a survey and the determination of the problem. The first chapter in this section presents data on the permissible dustiness of air in various industries. The next chapter gives an outline of the method of making a dust survey and discusses the requirements and limitations of dust determinations. The next two chapters deal with the actual methods of determining the amount of dust in the air. Practically all of the methods now used are presented. A determination of particle size is taken up in the following chapter while methods of making chemical and mineralogical analyses are discussed in the last chapter of this section.

The third and last section of the book deals with actual methods of controlling the dust hazard. In the first chapter of this section a general discussion of such methods is presented. A rather complete discussion is made in the following chapter of the methods of designing local exhaust systems. This chapter contains a large amount of engineering data which should be of considerable value to the designer of exhaust systems. The last three chapters deal with air cleaning apparatus, including gravitation settling chambers, cyclone chambers, inertial separators, ventilation apparatus, and dust respirators and air masks. A complete bibliography of the literature on industrial dust is included in the book. This bibliography occupies approximately 13 pages and lists some 260 references.

[*"Industrial Dust," by Philip Drinker and Theodore Hatch. Published by the McGraw-Hill Book Co., New York. Cloth bound, 6 x 9 in.; 316 pages, price, $4.*]

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Characteristics of Fuel Oil

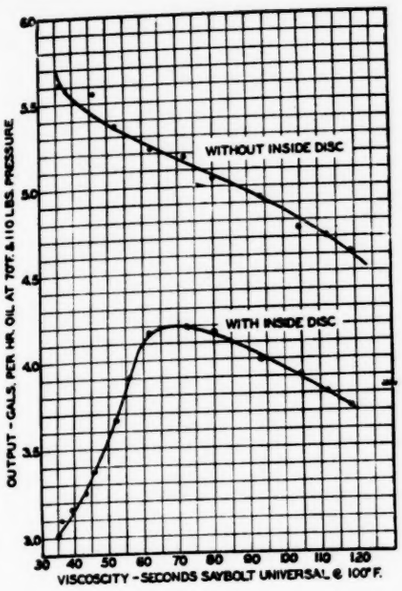
The question arises as to what effect carbon residue has on atomizing burners. Our work has shown that this class of burners is not so sensitive to the carbon residue of an oil as the vaporizing burners. Ordinary domestic pressure atomizing burners may be able to handle oil as high as 1% in carbon residue without giving any trouble, and, of course, some of the large industrial burners can handle No. 5 and No. 6 fuel oils that may run as high as 8% in the case of No. 5 and as high as 13% in the case of No. 6. But here we have burners which operate on an entirely different principle from the vaporizing burners and they are designed to handle this type of oil. The atomizing burners break the oil up into very fine particles and burn it in suspension before it has time to come in contact with any surface on which carbon might be deposited, provided, of course, the oil is atomized properly.

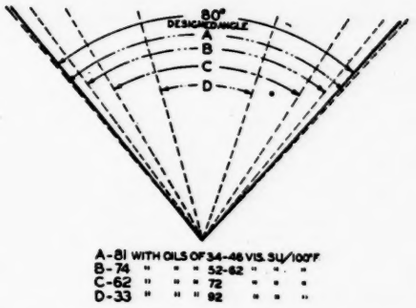
Proper atomization brings up another specification of the oil that must be considered in connection with atomizing burners. This specification is viscosity. All atomizing burners from the small domestic up to the large industrial burners are definitely limited by the viscosity of the oil that they can handle, that is, atomize properly. We recognize this limitation when we equip our large burners with preheaters and heat certain grades of oil before delivering them to these burners.

But the burners which we have found to be the most sensitive to the viscosity of the oil they burn are the small pressure atomizing domestic burners. These burners are of necessity designed to operate at low burning rates, therefore, we would expect them to be more sensitive to variations in oil specifications than some of the larger burners. For this reason care must be taken to see that this type of burner is supplied with oils which are uniform in viscosity. We cannot expect the burners to operate satisfactorily if we fill the customer's oil storage tanks with a 34-sec. viscosity oil this month and then next month deliver an oil of a 50-sec. viscosity.

The reason for this is that in changing from a 34-sec. to a 50-sec. viscosity oil it is likely to increase the burning rate as much as 25%. It sounds a little strange to say that more of a heavy oil may be forced through a nozzle than of a light oil in a given length of time without changing the pressure, but it's a fact. Where a pressure atomizing nozzle that delivers, let us say, 2 g.p.h. of No. 2 oil at 100 lb. pressure, is changed over to No. 4 oil of high viscosity, the output of the nozzle may jump to 3 g.p.h. or more.

Fig. 1 shows a chart which we have made up to show how the output of a nozzle increases as the viscosity of the oil increases. From this chart it may be seen how the capacity of a 3-gal. nozzle increased, up to a point at which the oil became so heavy that it could not be atomized properly. From this point on, the rate began to drop off, because then the nozzle was no longer an atomizing nozzle and when the output began to drop off, the curve took on the same slope as the straight orifice curve shown just above it.


OUTPUT - GALS. PER HR. OIL AT 70°F. & 110 LBS. PRESSURE
WITHOUT INSIDE DISC
WITH INSIDE DISC
VISCOSCITY - SECONDS SAYBOLT UNIVERSAL @ 100°F.



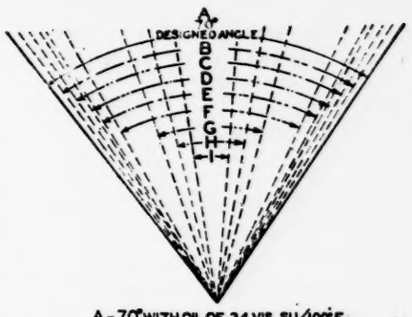


Fig. 1. (Left) Chart shows how the capacity of a 3-gal. pressure atomizing nozzle increased, as the viscosity of the oil increased, up to the point at which the oil became so heavy that it could not be atomized properly. The curve then takes on the same slope as the straight orifice curve just above it. Fig. 2. (Center) How one pressure atomizing nozzle retained its original spray angle on oil ranging from 34 to 46 sec., the spray not completely collapsing until a viscosity of 92 sec. was reached. Fig. 3. (Right) Effect of viscosity changes on spray angle of a pressure atomizing nozzle, using blends of No. 2 and special No. 4 oil.

In explaining this effect of viscosity on the output of a nozzle, we have to look at the design of the nozzle itself.

In the ordinary pressure atomizing nozzle the oil is fed under pressure into a vortex chamber, in the tip of the nozzle, through small slots in the nozzle disc. These slots are set at a tangent to the walls of the vortex chamber, thus causing the oil to swirl inside the chamber, and in so doing it builds up frictional resistance or back pressure which has a braking action on the oil and tends to slow it down. The faster the oil swirls, the greater this braking action becomes, and since the low viscosity oils tend to swirl faster than the higher viscosity oils, it is impossible to force as much of the lighter oils through the nozzle as of the heavier oils, under the same pressure.

This may explain why some people get the idea that they get so much more heat out of No. 3 or 4 oil than they do out of No. 2. We've had customers come in and tell us about how it was impossible to get up a half pound of steam in two hours of constant running on No. 2 oil, but as soon as they changed to No. 3, the burner was shutting off on pressure in 20 min., and they didn't think their burning rate was as high on the No. 3 oil as it was on No. 2. How could it have been when the No. 3 oil was heavier than No. 2? Actually, they may have been burning a half gallon more of the No. 3 oil per hour than of the No. 2, which was just enough to give them the extra "pick-up" they needed.

The viscosity of an oil not only affects the output of a nozzle, but it also affects the angle of spray. Some nozzles are more sensitive than others in this respect, depending on their design. We have examined some nozzles and found the spray angles to narrow down one or two degrees for every two or three seconds increase in the viscosity of the oil (see Fig. 3) and then we've had the spray completely collapse when the viscosity of the oil was increased to more than 40 sec., Saybolt Universal at 100F.

Fig. 2 is a chart which shows how one nozzle retained its original spray angle on oils ranging in viscosity from 34 up to 46 sec., and the spray did not completely collapse until oil having a viscosity of 92 sec. was reached. This we feel shows good nozzle performance.

As a general rule, we do not like to recommend an oil for use in pressure atomizing domestic burners which has a viscosity of more than 50 sec., Saybolt Universal at 100F.

And even then the climate in which the oil is to be sold has to be taken into consideration, because the viscosity of an oil is largely influenced by its temperature. One oil may give perfect performance when stored in a warm basement, but it may be impossible to use that same oil if the storage tank is outside exposed to zero weather.

Fig. 4 is a chart which shows how the fire of a pressure atomizing burner is affected by changes in the temperature of the oil. These changes actually took place as the temperature of an oil having a viscosity of 50 sec., Saybolt Universal at 100F was reduced, and the different stages through which the flame went were sketched, as shown in Fig. 4, at the time the tests were made.

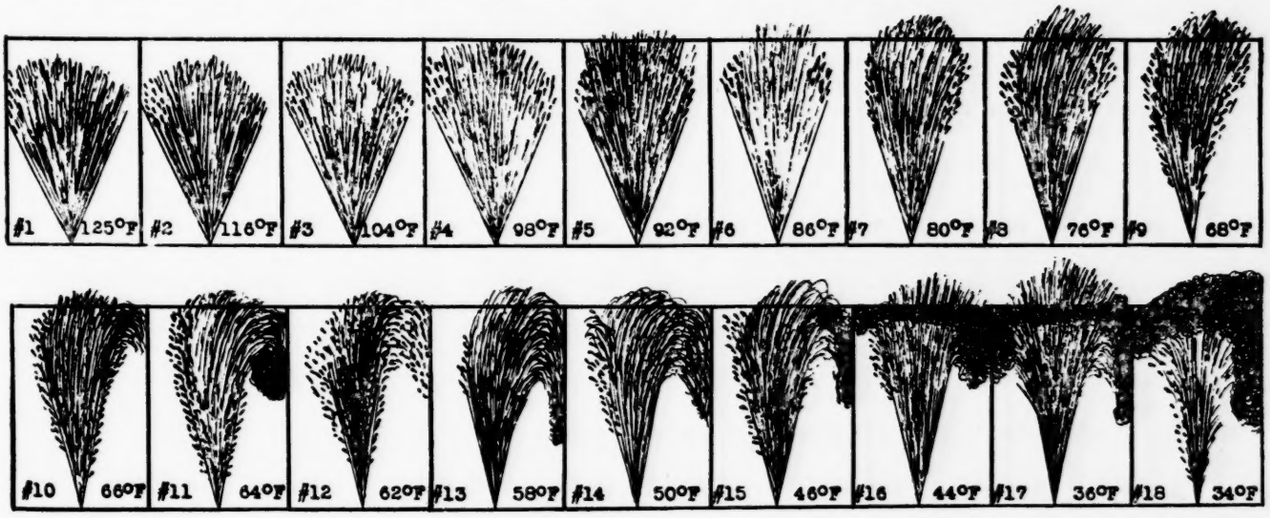


Fig 4. Chart showing how the fire of a pressure atomizing burner is affected by changes in the temperature of the oil. These changes took place as the temperature of an oil having a viscosity of 50 sec., Saybolt Universal at 100F was reduced.

It will be noticed that the flame was symmetrical and free of smoke and sparks at the higher temperatures, then it gradually became sparky and one sided as the temperature of the oil dropped, and finally the angle of spray became very narrow and the flame became smoky, indicating that poor atomization was taking place at the lower temperatures to which the oil was subjected. The pressure was maintained at 100 lb. throughout the tests. Only the temperature or, in other words, the viscosity, changed.

[*Abstracted from "Characteristics of Fuel Oil—Their Effect on Burner Performance," by E. B. Glendenning and W. A. Sullivan, Jr., of Shell Eastern Pet. Products Co.; published in the National Petroleum News, August 12, 1936, issue.*]

Economics of Gas House-Heating

This booklet was prepared by the American Gas Association to acquaint the various gas companies with the economics of the house-heating business. Its purpose is to present a method of analyzing the house-heating business; to show how the cost of service is derived; to provide a means of developing a rate which will get the business and to indicate a method of determining the point of saturation where a maximum return exists.

In drawing up this report the house-heating and air conditioning committee of the AGA has been very careful to specify the fundamental factors used which it felt were typical of average conditions in the industry. Wherever these factors cannot be made to fit a particular case the report is designed to enable one to easily revise it to fit his situation. Therefore, the report should enable one to make a proper analysis under any conditions even though they differ radically from those used in this report.

[*"A Study of the Economics of Gas House-heating," by A. M. Beebee. Published by the American Gas Association, 420 Lexington Ave., New York. Paper cover; 6 x 9 in.; 100 pages.*]

Design Problems of Heating and Ventilation

The primary purpose of this book is to present information which will enable the practising engineer and designer to shorten and at the same time to make more accurate the work involved in designing heating, ventilating, and air conditioning systems. In the introduction the author says that while there has been little change in the basic principles upon which heating and ventilating problems are based there is no doubt that there is room for methods of calculation by means of which time can be saved. According to the author the English engineers have been lax in utilizing the information which appears in foreign publications, particularly the German and French. To remedy this situation he has not hesitated to draw upon such sources for his material.

It is the author's belief that graphical solutions are of greater value in solving the problems involved. He has, therefore, eliminated, wherever possible, tables evaluating known formulas and has substituted instead graphical methods of presentation. In most cases, these graphs take the form of monograph charts and in all there are some fifteen of these charts presented for shortening the calculations in design problems.

As is to be expected the major section of the book is devoted to hot water heating. A large amount of valuable data is presented on single, two-pipe hot water systems, and radiant heating systems utilizing either gravity or forced pressure.

The second section deals with the design of hot and cold water supply systems and takes up such subjects as the determination of hot water requirements, pipe size, circulation of hot water, and design of systems for small buildings, hotels, and hospitals.

The problem of ventilation is discussed in the third chapter and the material presented includes data on the design of ventilating and air conditioning systems for various commercial buildings.

Industrial air conditioning is discussed in the following chapter. Included is material on air conditioning in the following industries; artificial silk, cotton, wool, drying and cleaning, printing, tobacco, and tea.

Chapter five deals with drying systems and discusses such problems as drying food crops, beet sugar pulp, hay and agar. District heating hot water schemes are dealt with in chapter six. Included are discussions of some of the leading district heating systems throughout the world as well as data on methods of heat distribution, pumping equipment, calorifiers and costs. Other chapters in the book are entitled steam distribution and boiler plants, dust and fume extractions, steam removal and pneumatic conveying, swimming baths and public wash houses and special requirements of factories and schools.

[*"Design Problems of Heating and Ventilation," by A. T. Henly. Published by Crosby Lockwood & Son, Ltd., Amen Corner, London, E.C.4. Cloth bound, 6 x 10 in.; 382 pages; price, 42s. net.*]

Ventilation Manual

This book is intended primarily for sheet metal contractors who are called upon to design and install ventilation. It deals with what might be termed ductless ventilation, the class of work in which propeller fans or roof ventilators are used, with but little or no ductwork. It is not intended for the designer of central systems employing extensive ductwork.

The first five parts are written to help the reader get a mastery of the principles of ventilation and include discussions of 1, business angle of contracting; 2, physical factors in ventilation; 3, specific problems, including heat conservation, heat removal, and fume removal; 4, equipment available; 5, design data and general principles of ventilation. In Part Six, covering specific applications, are 40 sections in which ventilating methods and layouts are explained and illustrated for as many different kinds of buildings or rooms. In these chapters the air supply for the particular building under consideration is given, with a typical layout or plan of ventilating the particular building or room.

[*"Ventilation Manual for Sheet Metal Contractors," by Paul R. Jordan. Published by Edwin A. Scott, 45 W. 45 St., New York. Cloth bound; 5 x 7 in.; 346 pages; price, $3, postpaid.*]

Corrosion in Steam Heating Systems

This paper is a second preliminary report of a study on corrosion in steam heating systems being conducted at the Michigan College of Mining and Technology. Up to the present time 40 corrosion tests have been made at various pressures and with various gas concentrations. The following points were considered:

1. The effect of pressure on the corrosion rate.
2. The effect of oxygen and carbon-dioxide on the corrosion rate.
3. Correlation of the rate of corrosion as measured by the corrosion tester to the actual life of the pipe.
4. A study of an electric resistance method to determine corrosion rates.

These tests are by no means complete and the information is offered merely to promote discussion.

It is felt that the range of tests conducted so far is not sufficiently wide to attempt to correlate the various factors in their combined effect in producing corrosion in return piping. However, the results bear out the following general statements:

Other factors being constant, the corrosion rate will vary directly with the oxygen content of the condensate.

Again assuming other factors are constant, the corrosion rate will vary directly with the free CO_2 content of the condensate, at least up to about 30 parts per million. One part per million of oxygen appears to have about the same corrosive effect as 20-30 parts per million of CO_2.

The corrosion rate was found to increase with increases of the condensate temperature from 80F to approximately 120F. Above this temperature the corrosion rate showed a steady decrease for further increases in temperature.

Assuming that the quality of steam is the same, a decrease in pressure will result in a decrease in the rate of corrosion in a tight system.

[*"Corrosion Studies in Steam Heating Systems," by R. R. Seeber, F. A. Rohrman, and G. E. Smedberg, Houghton, Mich. Paper presented at the 42nd semi-annual meeting of the ASHVE, June, 1936.*]

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Iced Air Conditioning Manual

During the past three years the Union Ice Company of San Francisco has been selling iced air conditioning systems in San Francisco and neighboring towns. Their experience has showed them the necessity of assigning to one man in each district the promotion of this use of ice. To assist these men, this manual has been prepared.

The purpose of the manual is to acquaint these men with what has already been accomplished in this field, to show them what can be done with ice and what method has to be followed to make such an installation.

The first section of the book is taken up with a list of the iced air conditioning installations which have been made in California and also a number of pictures and testimonials from the owners of the actual installations.

The second section is devoted to instructions to salesmen and outlines the method to be followed in selling a prospect. The duties of the salesman are summed up in this statement. The object of the promotional salesman is to create a desire for iced air conditioning and a willingness to spend about the amount of money that the survey and estimate of the engineer will show is required to get satisfactory performance.

The principles of air conditioning, including the definition of the various terms, the estimation of the heat load, and the selection of equipment are dealt with in the third section. Following this is a sheet comparing ice and mechanical cooling.

[*"Selling Iced Air Conditioning," by H. L. Lincoln and V. V. Ogburn. Published by The Union Ice Co., 354 Pine St., San Francisco, Calif. Heavy paper cover; 8½ x 11 in.; 45 pages.*]

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Course in Coal Utilization

From the 9th to the 11th of June a large number of men, interested in the subject of coal and coal burning, attended the Third Short Course in Coal Utilization at the University of Illinois and heard a wide variety of subjects discussed by various specialists in the field. These subjects ranged all the way from the transportation of coal to the more recent developments in air conditioning.

These talks have been gathered together and printed in booklet form to enable those who were unable to attend to review the principles of the course.

The subjects reprinted in this booklet include the following: transportation of coal, what's what in air conditioning, new developments in stokers, elementary calculations for domestic stoker installations, a year 'round hot water supply, small steam plants, changing trends in heating, trouble shooting in large heating plants, some things learned about selling stokers, selling heat service vs. selling coal, large steam plants, B.t.u. determination, types of solid fuel and sampling coal shipments.

[*"Proceedings of the Third Short Course In Coal Utilization," published by Coal-Heat, 20 West Jackson Blvd., Chicago. Paper cover; 6 x 9 in.; 145 pages; price, $1.50, postpaid.*]

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Degree-Day Vestbook

The degree-day method of estimating fuel consumptions has been in use now for approximately 18 years. Every year more and more persons are employing this rapid and accurate method of estimating fuel consumptions.

Since 1927, HEATING & VENTILATING has published degree-day and unit fuel consumption figures every month during the heating season. This widespread publicity has resulted in the development of a number of uses other than for estimating fuel consumption. Some of the more important of these in use at the present time are checking daily and monthly fuel consumption figures; justifying bills for gas, oil, and coal heating, and checking heating plants for economical operation.

To help those persons who are not familiar with the degree-day, this Vestbook has been written. In the first part of the book a brief mention is made of the history of the degree-day. Following this is a table which lists the normal yearly degree-day figures for 94 of the more important cities. These figures are based on data gathered over a period of 20 to 50 years ending about 1922.

A definition of the degree-day and the method of using these figures are outlined on page 9. Following this is an explanation of the method of computing the degree-day and unit fuel consumption figures. Included in this section is a discussion of the points to watch out for in applying this method. In the latter part of this book is presented an example of the use of the degree-day.

["HEATING & VENTILATING'S *Degree-Day Vestbook*," *published by* HEATING & VENTILATING, *148 Lafayette St., New York. Paper cover; 3 x 5 in.; 16 pages. A limited number of copies of this vestbook is available on request. Address Degree-Day Department.*]

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BRIEF REVIEWS

DOMESTIC STOKERS. A report of tests conducted on underfeed domestic stokers burning bituminous coal. For a review of this paper, see July, 1936 issue of HEATING & VENTILATING, page 51. [*"Performance of an Underfeed Domestic Stoker," by T. G. Estep and D. C. Saylor. Paper presented before semi-annual meeting of ASHVE, June, 1936.*]

AMERICAN GAS CATALOG AND HANDBOOK — The 1936 edition of the handbook. Its purpose is to make available a compilation of technical data and information which will be of practical usefulness to members of the gas industry. Contains a number of charts and tables which are standard; also some which have been compiled by maufacturers and others prepared by the publishers. [*"American Gas Catalog and Handbook — 1936 Edition," published by American Gas Journal, 53 Park Place, New York; cloth bound; 9 x 12 in.; 184 pages.*]

SELECTING REFRIGERATING EQUIPMENT. This paper analyzes the actual conditions of operation which a refrigeration system should be designed to meet when installed for comfort air conditioning, and establishes a basis for the proper balancing and selection of compressor, condenser and evaporator for usual conditions of operation encountered. [*"Application Factors which Govern the Selection of Refrigerating Equipment for Air Conditioning Service," by J. R. Hertzler. Paper presented at ASRE semi-annual meeting, Buck Hill Falls, Pa., June, 1936.*]

NEWS OF THE MONTH

Campaign on Air Conditioning with Radiator Heat Ready for Other Cities; Test in Chicago Successful

CHICAGO — With the success of the test campaign for the promotion of air conditioning with radiator heating assured in Chicago, the campaign is now ready for other cities. This was the decision reached at a meeting of the plan and scope committee of the National Bureau of Heating and Air Conditioning at the Hotel Sherman here August 3.

According to Louis Braun, secretary of the Chicago Master Steamfitters Association, following the meetings of master steamfitters, salesmen employed by manufacturers and wholesalers, and architects and engineers, sectional meetings of contractors were held on the south side of Chicago, the west side, and the north side. These were follow-up meetings at which the sales manual was discussed, section by section.

Mr. Braun reported to the committee on the enthusiasm for air conditioning with radiator heating developed among radiator heat contractors as a result of the campaign, and referred to the new promotional material now being prepared by the copy committee of the National Bureau of Heating and Air Conditioning. This consists of a booklet for distribution to consumers and mailing pieces to be sent to prospective builders.

"Chicago was selected as the test city for the campaign," J. L. DeNeille, president of the Bureau, stated. "The committee wished to make a thorough trial of every phase of the campaign in some one representative city before making it national.

"The test period is nearly over. The Chicago contractors have expressed themselves as thoroughly satisfied with the campaign and the promotional materials in every respect. Therefore, the campaign can now be extended to other cities which are ready and which can meet the qualifications set up."

While the campaign in other cities will be handled in close cooperation with the local associations affiliated with the Heating, Piping and Air Conditioning Contractors National Association, participation will not be limited to contractors who are association members.

"This is a campaign for the entire radiator heating industry," Mr. DeNeille explained. "The campaign includes the man who installs only three or four heating plants a year as well as the large contractor. It embraces the manufacturer and distributor as well as the journeyman steamfitter.

"In fact, one of the outstanding facts demonstrated by the campaign is that the radiator heating industry can think and act as a unit. The campaign has demonstrated the soundness of the plan of action as well as the confidence of the industry in the merits of air conditioning with radiator heating.

"We have developed and put into effect a long-term program. This fact should be thoroughly understood by all members of the industry. It is not a short-term or emergency program. It is a program for the long pull. The greatest danger to the success of the program that could possibly arise would be the complacency of the industry coming from the increasing volume of sales."

In line with the statement of President DeNeille about the future of the program, the committee adopted a series of recommendations for the immediate as well as the more remote future of the campaign. These recommendations, which include further development and expansion of the sales promotion materials as well as a research program will be submitted to the Executive Committee.

The meeting was attended by the following members of the committee and officers of the Bureau: Mr. DeNeille; J. C. Fitts, New York, secretary, Heating, Piping, and Air Conditioning Contractors National Association; Marshall Adams, manager, sales promotion department, American Radiator Co.; Russell G. Creviston, director, advertising and sales promotion, Crane Co.; Martin Weil, vice-president, Weil-McLain Co.; C. G. Newton, vice-president, Stevens-Root Co.; Norman J. Radder, secretary, Plumbing and Heating Industries Bureau; R. B. Dickson, president, Kewanee Boiler Corp.; A. G. Dixon, sales manager, Modine Mfg. Co., and president of the Industrial Unit Heater Association. Mr. Braun was a guest of the committee.

26 A.C. Jobs in Birmingham

BIRMINGHAM, ALA. — Twenty-six air conditioning installations, with a total of 496 hp., were made in Birmingham during the first half of 1936, according to Harold V. Fried, manager of the Birmingham Air Conditioning Bureau.

The installations included nine in retail stores, seven in office or office buildings, four in residences, two in hotel coffee shops, two in restaurants, one in a hotel (one floor) and one in a theater. The largest installation of 115 hp. was in the department store of J. Blach & Sons. Silver's 5 and 10-cent store made an 80-ton installation.

Anthracite Operators Start Campaign

NEW YORK — Anthracite operators have organized Anthracite Industries, Inc., to "acquaint the public with the many new and modern developments in the use of anthracite and anthracite-burning equipment." Offices have been established in the Chrysler Bldg., New York, and an advertising program costing between $750,000 and $1,000,000 a year will be administered by the Simpers agency, Philadelphia.

President of Anthracite Industries, Inc., is Frank W. Earnest, Jr., a former vice-president and general manager of Spencer Heater Co. Members of the board are: Eliot Farley, D. L. & W. Coal Co.; Ralph E. Taggart, Philadelphia & Reading Coal Co.; F. W. Leamy, Hudson Coal Co.; J. B. Warriner, Lehigh Coal and Navigation Co.; Oscar F. Ostby, Independent Anthracite Coals, Inc.; John Gilbert, Madeira, Hill & Co.; A. C. Dodson, Weston Dodson & Co., Inc.; Thomas Dickson, Dickson & Eddy; Donald Markle, Jeddo-Highland Coal Co.; and Louis C. Madeira, 3rd, executive director of Anthracite Institute.

Agreement Reached on Burner Pilots

DETROIT—A peaceful agreement has been reached between the gas company and oil interests here regarding the ten or twelve thousand oil burners installed in this city and having gas pilots which are unable to burn the newly introduced natural gas now supplied. The utility will make the change-over at its own expense which will amount to more than $50,000.

The work will be done by the oil burner companies who are pooling their services in order to complete the job efficiently and quickly, working through the Detroit Oil Heat Committee. The gas company will reimburse the committee for this service at the rate of $4.50 per burner with one pilot and $7.50 per burner with two pilots. Consumers using obsolete equipment where the adjustment might be hazardous will be so notified. Persons desiring to make arrangements for their own adjustments may do so.

Union Protests Foreign Fittings

NEW YORK—A resolution protesting against the importation into the United States of pipe fittings made in foreign countries was recently passed by the Alteration Plumbers, Steamfitters and Helpers Union, 80 E. 11th St., New York. The Union has refused to install foreign-made fittings because of their alleged inferior quality.

Battelle Available for Coal Studies

WASHINGTON, D. C.—Widespread interest in its research studies in coal and related equipment at Battelle Memorial Institute has influenced Bituminous Coal Research, Inc., to make its laboratory available to coal producers and stoker manufacturers for the study of individual problems which are not included in its general program.

Many inquiries have been received from individual coal producers and from stoker manufacturers concerning specific problems of their individual products. The studies conducted by the corporation are general in character and intended to be of the greatest possible benefit to the industry as a whole. In carrying on these investigations a rather complete laboratory has been developed which is capable of handling a greater volume of work than the corporation is conducting. It is the surplus capacity that is being offered to individual producers and manufacturers on the most favorable terms possible.

Coal producers and stoker manufacturers desiring to avail themselves of these facilities should communicate direct with Clyde E. Williams, director, Battelle Memorial Institute, Columbus, Ohio.

Waterfill and Bulkeley to Teach A.C.

NEW YORK—Studies in noise, sound vibration in buildings, and other disturbing factors which intensify the discomforts of city life and decimate property values will be launched by the Columbia School of Architecture this fall, according to Prof. George M. Allen, who will direct a new program of instruction in the University Extension.

Building acoustics, air conditioning, illumination, and structural and decorative materials, are included in a large group of evening courses to be conducted by a teaching staff composed of physicists, architects, engineers, and experts from the industries.

Two courses in air conditioning will be given in collaboration with the Department of Mechanical Engineering "to clarify the principles and practical technical requirements of this rapidly growing industry." One, explaining the equipment and the theory of processes for air conditioning, will be directed by R. W. Waterfill of the Buensod-Stacey Air Conditioning, Inc.; the other, dealing with the technical requirements underlying the design, installation and operation of air conditioning equipment in both the industrial and comfort fields, will be taught by C. A. Bulkeley, chief engineer of the Niagara Blower Co.

Air Hygiene Institute Gets Under Way

PITTSBURGH — Air Hygiene Foundation of America, Inc., with headquarters at Mellon Institute of Industrial Research, is directing a broad, scientific study of problems of air contamination, toxic fumes, and gases. The Foundation was incorporated last December after more than a year of preparation. The purpose of the research program upon which work is under way is the elimination or reduction to safe concentrations in plants and industrial operations of dusts and fumes known or suspected to be harmful to those inhaling them.

The first step toward this goal necessitates the collection of all available data on the subject, knowledge which has accumulated in many places through the years but which has not been assembled, evaluated and unified into a compact, usable body of information.

Stripped Roofs Give Airflow in Rooms

BIRMINGHAM, ALA.—A somewhat novel ventilation principle is provided for seven tamped earth houses built by the Resettlement Administration as an experiment at Gardendale Homesteads near here. The sheet metal roofs are flat, with minimum sun exposure.

Utilizing the difference in heat absorption between black and white, stripes are painted on the metal roofing surface, creating channels of airflow directly beneath it. By connecting with vents in the walls, a flow of air is maintained through the rooms. In winter, cream and blue walls help to employ the same principle in distribution of heat from a central source.

ASTM Changes Tests for Coal and Coke

NEW YORK—A revision of the standard methods of laboratory sampling and analysis of coal and coke, to include certain low-temperature cokes, green cokes, chars, anthracites, and semi-anthracites, has been proposed for publication as tentative standard by the American Society for Testing Materials' Committee on Coal and Coke.

These fuels, it has been found, should be given the preliminary heat treatment to prevent too rapid evolution of moisture and gases, which the original standard prescribes for subbituminous coal, lignite, and peat. This heat treatment is part of the modified procedure for the determination of volatile matter given in the standard. The proposed revision also includes more detailed instructions for this modified method.

A.C. Courses at Brooklyn Poly

NEW YORK—Evening courses in heating, ventilating, and air conditioning are being offered by the Polytechnic Institute of Brooklyn, New York, during the 1936-37 school sessions, starting this September, according to Prof. E. F. Church, Jr., head of the mechanical engineering department. Registration is to be held during the week of September 18, following which classes will be held on Wednesday and Friday evenings. The classes will deal with the fundamentals of heating and ventilating, while during the second semester, beginning in February, 1937, advanced considerations on air-conditioning will be covered. Both courses will be under the direction of John James of the technical staff of the ASHVE.

Werner Nygren

NEW YORK — Werner Nygren, president of Werner Nygren, Inc., prominent consulting heating and ventilating engineer of this city, designer of the mechanical equipment of many of New York's well known buildings, died August 28 at his home in Freeport, L. I. He was 68 years old.

Born in Sweden, where he received his early technical training, Mr. Nygren came to the United States at the age of 20 to work for the General Electric Co. in Lynn, Mass. He later moved to Boston and during 1894-5 was designer of heating and ventilating equipment for the city architect. He then came to New York and became associated with Alfred R. Wolff, a consulting engineer, upon whose death in 1909 he became a member of the firm of Nygren, Tenney & Ohmes. In 1915 he withdrew from that company to practice under his own name.

In 1904 Mr. Nygren installed an air conditioning system in the New York stock exchange, one of the first of such installations on record.

A past president of the New York Association of Consulting Engineers and of the Heating Board of Trade, Mr. Nygren served as a member of the advisory commission of the Council of National Defense during the World War.

He was a member of the American Society of Mechanical Engineers, American Society of Swedish Engineers, New York Association of Consulting Engineers, Engineers Club, New York Building Congress, and Metropolitan Museum of Art.

He is survived by two daughters and two sons.

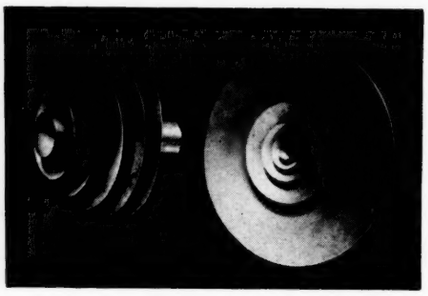
NEW EQUIPMENT

Anemostat Air Inlet

NAME AND MODEL NUMBER — Anemostats, types A. B & C.

PURPOSE—For supplying high velocity air to a room without objectionable noises or drafts.

FEATURES—Anemostat is made up of a



Type A and Type C Anemostats

number of truncated cones which are used to break up and expand the high velocity air stream so that it enters the room without causing drafts. The manufacturer claims that the device is so constructed that the velocity of the air current passing through the inlet neck can be reduced down to one-twentieth of the initial velocity. By a re-arrangement of the cones the Anemostat can be made to provide any outlet speed or distribution. The velocity of the air as it emerges from the unit can be made practically uniform over the entire surface or may be given any desired value in any direction. The Anemostat also draws a small proportion of the room air in through the center cone and mixes it with the conditioned air before it is distributed to the outer cones. The resistance of the Anemostat is said to be about 30% higher than 90° bend in a duct of the same diameter as the Anemostat neck.

SIZES AND CAPACITIES—Type A is used for air velocity up to 5,000 f.p.m.; type B for velocity up to 4,000 f.p.m. and type C for velocity up to 2,500 f.p.m. Capacities range from 34 to 3,200 c.f.m.

MADE BY—*Anemostat Corporation of America, 551 Fifth Ave., New York.*

Link-Belt Radiostat Control

NAME AND MODEL NUMBER—Link-Belt Radiostat Control.

PURPOSE—An electronic controlled device known as the radiostat control which is used to regulate the operation of stokers from the outside air temperature.

FEATURES — A heat sensitive element is placed on the outside north wall of the building while a boiler unit is submerged just below the water level in the boiler and a return line element is placed on a condensate line coming from the part of the building where it is most desirable to control the temperature. Lines lead from these three devices to a master control installed on the wall of the basement. It is said that the electronic tubes of the control device are sensitive to changes of as little as 1F and once the device is installed and adjusted, it needs no further attention regardless of weather conditions. The only moving part in the Radiostat is a motor starting relay. Manufacturers claim a saving of approximately 15% in the use of steam above the boiler room.

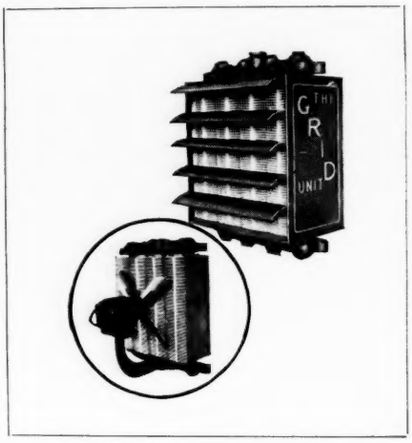
MADE BY—*Link-Belt Co., Stoker Division, 2410 W. 18 St., Chicago, Ill.*

Grid Unit Heater

NAME AND MODEL NUMBER—Grid unit heater, Nos. 515, 520, 525, and 530.

FEATURES—All-cast aluminum heating sections bound to the steam chamber in such a manner that it is said to prevent electrolysis. These new units are identical with other units of the Grid line except for size.

SIZES AND CAPACITIES—Four sizes with



capacities ranging from 56,750 to 248,000 B.t.u. per hr.

MADE BY — *Unit Heater & Cooler Co., Wausau, Wis.*

Jenkins Solder-End Valves

NAME—Jenkins solder-end valves.

PURPOSE—Standard valves for installation on soldered copper pipes or tubes.

FEATURES—These valves are identical with the standard Jenkins valve in every detail except for the ends which are so designed to make possible soldered connection to copper lines. Either globe, angle, or lift check valves are available.

SIZES AND CAPACITIES—For installation on ¼ in. to 3 in. lines.

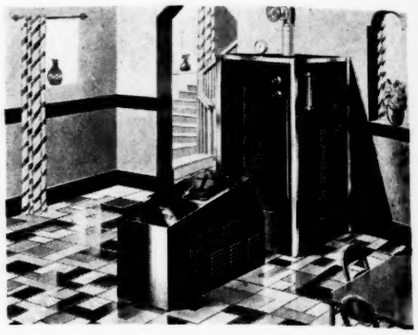
MADE BY — *Jenkins Bros., 80 White St., New York, N. Y.*

Anchor-Arco Stoker Boiler

NAME AND MODEL NUMBER — Anchor-Arco Kolstoker Boiler unit.

PURPOSE — Combination coal stoker and boiler.

FEATURES—Manufacturers claim a high ef-



ficiency for this unit due to the fact that the automatic coal burner has been installed in boiler designed and built especially for the requirements of automatic coal firing. The unit is finished in bright red and black.

MADE BY—*American Radiator Co., 40 West 40 St., New York, and Anchor Stove and Range Co., New Albany, Ind.*

AFCO Oil Burning Unit

NAME AND MODEL NUMBER—AFCO Air Stream Oil Burning Unit.

PURPOSE—Supplies humidified, filtered, circulated and warmed air, utilizing oil as a fuel.

FEATURES—Viscous type air filters for cleaning; a full floating, centrifugal type blower for air circulation; gun type oil burner with electric ignition for heating and either a drip type or control type humidifier for adding moisture to the air. The combustion unit is fabricated of a heavy boiler plate—8 gauge for the combustion chamber and 14 gauge for the secondary surface. The cabinet is of double wall construction made up of heavy sheet iron inner and outer walls with ½ in. asbestos insulation between them.

SIZES AND CAPACITIES—Four sizes from 141,000 to 564,000 B.t.u. per hour input.

MADE BY—*American Furnace Co., 2719 Delmar Blvd., St. Louis. Mo.*

Armco Paintgrip Sheets

NAME AND MODEL NUMBER — Armco Galvanized Paintgrip sheets.

PURPOSE—A new type of galvanized sheet metal which can be painted without special treatment of the surface by the user.

FEATURES—Manufacturers claim that the new paint grip sheets have all the value of full coated galvanized sheets with the added protection of a special insulating coating that keeps the paint from direct contact with the zinc surface. It is said that the forming qualities are the same as untreated galvanized sheets with corresponding weights of coating. Paintgrip treatment is available in any of the grades of galvanized sheets and is supplied in two surface finishes, regular and extra-smooth.

MADE BY—*The American Rolling Mill Co., Middletown, Ohio.*

G-E Sound Level Meter

NAME—G-E sound level meter.

PURPOSE—To give a quantitative measure of noise, independent of the personal element, and at the same time to give results commensurate with sensations experienced by the ear.

FEATURES — The meter was developed to provide performance in accord with the newly adopted American Standards Association standard. Special precautions have been taken to

make the instrument suitable for use in a neighborhood of electrical machinery where stray magnetic fields are common. The meter is calibrated to read in decibels and its range is from 30 to 120 decibels. A small calibrating unit is provided to insure accurate overall field calibration. The complete instrument, including microphone, tripod, calibrating unit and batteries, is contained in a metal case weighing approximately 39 lb.

SIZES AND CAPACITIES—Range from 30 to 120 decibels.

MADE BY—*General Electric Co., 1 River Road, Schenectady, N. Y.*

Master Kraft Warm Air Unit

NAME AND MODEL NUMBER — Master Kraft Conditioned Warm Air Heating Unit.

PURPOSE—Winter air conditioning, consisting of filtering, heating, circulating and air moistening, utilizing oil as a fuel.

FEATURES—A double sized radiator which is said to increase considerably the amount of heat obtained. Heater has but two joints, one sealed with insulation and refractory and the other sealed by iron to iron construction protected by high temperature cement on both sides. Oil burner is of gun type with a Thermo overload release switch to prevent burned out motors.

SIZES AND CAPACITIES — Four units, 100,000 to 190,000 B.t.u. per hr. at the register.

MADE BY—*Harvey-Whipple, Inc., 55 Emery St., Springfield, Mass.*

Arco Floor and Ceiling Plate

NAME AND MODEL NUMBER—Arco Floor and Ceiling Plate.

PURPOSE—A floor and ceiling plate made especially for installing on copper pipe used on inside installations in plumbing, heating, air conditioning and refrigeration systems.

PURPOSE—Plate has a special spring on the inside diameter which grips the pipe and is said to hold the plate snugly in place without annoying rattles. It has a non-tarnish chrome finish.

SIZES AND CAPACITIES—⅜ to 1 in.

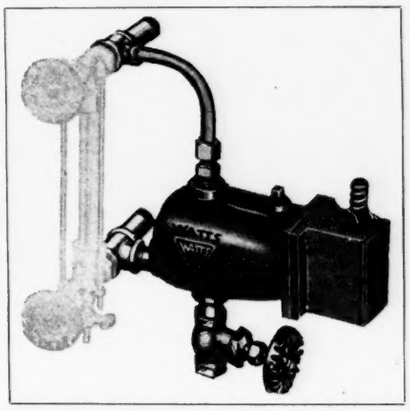
MADE BY—*American Radiator Co., 40 West 40 St., New York.*

Watts Low Water Cut-Off

NAME AND MODEL NUMBER—No. 94 low water cut-off.

PURPOSE—To protect automatically fired boilers, either gas, oil, or stoker fired, from danger due to low water level.

FEATURES — Flexible bellows seal acting upon a precision switch of the magnetic principle. The unit has the quick pickup connection so that it can be installed in the present gage glass tapping. Measures 9 in. in length by 3 in. in width. Steam pressure is set at 15 lb.



SIZES AND CAPACITIES—½ hp. maximum, 110 to 220 volts, a.c.

MADE BY—*Watts Regulator Co., Lawrence, Mass.*

Lincoln Welding Machine

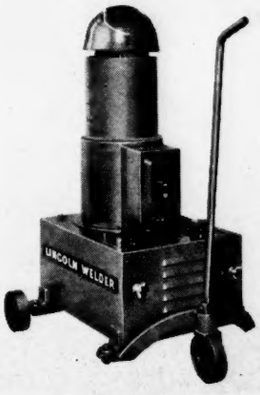
NAME AND MODEL NUMBER—Arc Welding Machine, model SA-150.

PURPOSE—Intended for a wide variety of applications, such as sheet metal work, pipe welding, cast iron repair and regular production welding.

FEATURES—Unit is insulated with Class B insulation which, the manufacturer claims, insures it against burn outs and permits sustained overloads without injurious effect. Can be used with either bare or shielded arc type electrodes. Has a dual control of voltage and current, allowing independent adjustment of arc heat and arc penetration to suit the welding application.

SIZES AND CAPACITIES — Available for 60 cycle power circuits of 220 or 440 volts, three or two phase. Rated current range of 45 to 200 amperes. Either portable or stationary models are available.

MADE BY—*The Lincoln Electric Co., Cleveland, Ohio.*

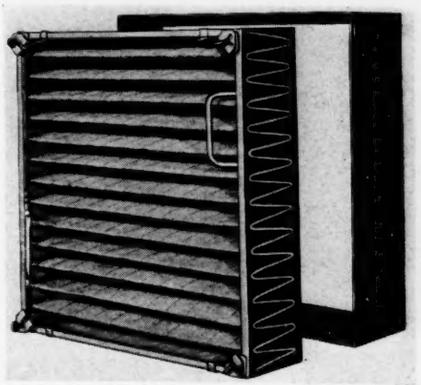


American Airmat Filter

NAME AND MODEL NUMBER — Airmat PL-24 filter.

PURPOSE—A dry filter of a new design for air conditioning service.

FEATURES—Standard unit construction with an interchangeable filter element and frame. The filter element is composed of two matched serrated sections which support the Airmat in deep pleats to provide maximum filtering area and to seal the saw-tooth edges against air



leakage. The filtering material, which is furnished in rolls, is applied to the filter element by means of a simple loader. Either 6-ply or 10-ply Airmat may be used, depending upon the air cleaning requirements of the application.

SIZES AND CAPACITIES—24 in. square by 8 5/16 in. deep, rated at 1,000 c.f.m.

MADE BY—*American Air Filter Co., Inc., Louisville, Ky.*

Carrier Air Conditioners

NAME AND MODEL NUMBER — Carrier Home Air Conditioners.

PURPOSE—Winter or year round air conditioning utilizing either oil or gas.

FEATURES—Throw-away type filters for air cleaning; evaporative pan type humidifier with complete remote control for humidifying; forward curved blade fan for air moving; fin type coils for heating. When summer cooling is desired a fin type cooling coil can be installed. Oil burner is of the gun type with spark ignition. The air conditioner is made up of two units—the furnace and air conditioning unit. The air conditioning unit is placed on top of the furnace to decrease the amount of floor space required. An 18 gage steel jacket with crackle enamel finish is used to house the units.

SIZES AND CAPACITIES—Oil fired—190,000 and 323,000 B.t.u. per hr. Gas fired—150,000 and 260,000 B.t.u. per hr.

MADE BY — *Carrier Engineering Corp., 850 Frelinghuysen Ave., Newark, N. J.*

Arcoloy Range Boiler and Tank

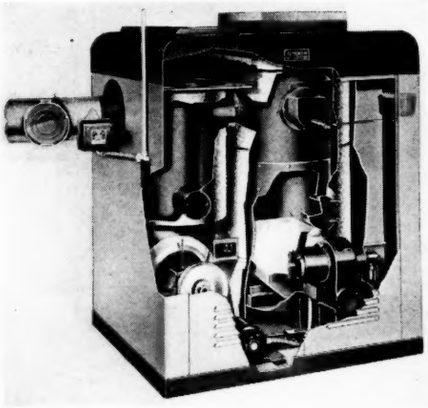
NAME AND MODEL NUMBER — Arcoloy Range Boiler and Tank.

PURPOSE—A hot water storage tank.

FEATURES—Tank is made of arcoloy, a patented metal which the manufacturer claims has unusual ability to resist corrosion. The tanks have a burnished finish protected by a light coat of lacquer. All tanks are guaranteed for 20 years.

SIZES AND CAPACITIES—25 to 100 gallons.

MADE BY—*American Radiator Co., 40 West 40 St., New York.*



Timken Oil Furnace

NAME AND MODEL NUMBER—Model GC 20-A winter air conditioning oil furnace.

PURPOSE—Chromium steel firebox which replaces the usual brick or cast refractory, and which is said to increase considerably the efficiency of heating surface. Cabinet is of heavy gage steel, finished in baked, green lacquer. Humidifier is equipped with automatic water supply mechanism.

SIZES AND CAPACITIES — 80,000 B.t.u. per hr. at the register with an air delivery from 800 to 1,200 c.f.m.

MADE BY—*Timken Silent Automatic Div., The Timken-Detroit Axle Co., Detroit, Mich.*

National Radiator Steel Boiler

NAME—National Premier oil heating, jacketed, vertical steel boiler.

PURPOSE—To supply steam or hot water, utilizing oil as a fuel.

FEATURES—Gases from the vertical circular combustion chamber pass through a series of short tubes to a front chamber and then through a longer series to the smokebox. Turbulators are installed in each tube to cause the gases to swirl, increasing the scrubbing effect. Three sizes of built-in copper coils can be furnished for supplying domestic hot water—two sizes for storage systems and one for instantaneous systems. Other built-in equipment includes low water cutoff, an observation port, automatic draft adjuster, and aquastat tappings. Heavy air cell insulation surrounds the boiler. Boilers are furnished with either a standard jacket or with a front extension to enclose gun type burners and other controls. It is also said that the boilers are well adapted for use with stokers.

SIZES AND CAPACITIES—Two sizes with steam ratings of 540 and 680 sq. ft.

MADE BY—*National Radiator Corp., 221 Central Ave., Johnston, Pa.*

Chicago Expansion Bolt

NAME AND MODEL NUMBER—Life Time Expansion Bolt.

PURPOSE—An expansion bolt for extreme loads and vibrations.

FEATURES—The bolt is made of steel, has a thin steel cone jacket under the bolt head and a lead jacket on the outside. The manufacturer claims that the bolt has holding power up to the actual breaking point of the steel bolt.

SIZES AND CAPACITIES—Available in sizes from ¼ to ½ in. diameter and 1½ to 8 in. long. Finished in plain, cadmium or hot galvanized. Special sizes to order.

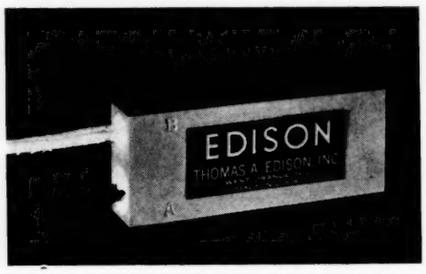
MADE BY—*Chicago Expansion Bolt Co., Room 684, 126 So. Clinton St., Chicago, Ill.*

Edison Time Delay Relay

NAME AND MODEL NUMBER — Edison "Sealed Protection" Time Delay device.

PURPOSE—An adjustable time delay relay for use with heating devices to remove from the circuit an accelerating heat-up unit as the device attains its operating temperature.

METHOD OF OPERATION—A small external resistor on the timing relay enables the operator to adjust it to give time delay periods in the order of 10 to 15 minutes. In principle, the relay operates as a thermal inertia device depending for its period upon the time required to heat the block to a predetermined temperature. The relay can be furnished for either open or closed circuit operation.



SIZES AND CAPACITIES—Will handle 800 watts at voltages up to 230, AC or DC.

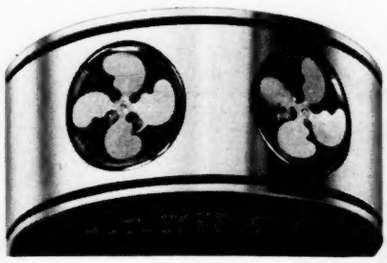
MADE BY—*Thomas A. Edison, Inc., West Orange, New Jersey.*

Peerless Air Conditioners

NAME—A floor type, ceiling type, and ceiling-suspension type comfort cooler, band box model.

PURPOSE—To supply cooled and dehumidified air.

FEATURES—Floor and ceiling models: refrigerant coils in these units are standard Peerless rifled tubing coils equipped with Equa-Lizer feed to ensure proper distribution of the refrigerant. The units are not equipped with filters, but may be used with any standard filter of adequate capacity. The band box model comfort cooler is designed for application in offices, shops, and homes. Incorporated in the cabinet are expansion coils and valves, a drip pan, motors and two fans. An all-aluminum case with black trim is used to house this equipment. Coils are furnished for three point suspension by means of hanger bolts secured to the ceiling above. Each cooling unit employs two fans to secure proper distribution of the air.



SIZES AND CAPACITIES—Floor and ceiling type units: 12 sizes with capacities ranging from 1 to 20 tons; band box comfort cooler, 4 sizes with capacities ranging from 9,000 to 24,000 B.t.u. per hr., cooling effect.

MADE BY — *Peerless Ice Machine Co., 515 W. 35 St., Chicago, Ill.*

Kauffman Unit Air Conditioner

NAME—Kauffman cooling unit.

PURPOSE—For cooling small rooms.

FEATURES—Cools, dehumidifies, filters, circulates 275 c.f.m. Unit is mounted on casters and no plumbing or drain connections are necessary.

SIZES AND CAPACITIES — ¾-ton cooling capacity.

MADE BY—*Kauffman Air Conditioning Corp., 4485 Olive St., St. Louis, Mo.*

De La Vergne Air Conditioners

NAME AND MODEL NUMBER—Models AA and AW unit air conditioners.

PURPOSE—AA models for summer air conditioning only unless equipped with reversed refrigeration or steam coils. Models AW for summer air conditioning only unless equipped with steam coils.

FEATURES—AA models require only a connection to electric lines and a duct to outside air. Reversed refrigeration equipment for heating during the winter is optional on all AA models. Nos. 1 and 1½ units are floor type while No. 4 unit is the ceiling type. AW units require a connection to electric line, water supply and drain. If these units are to be used for heating a steam coil is provided. Freon is used in all units. Compressor unit is sealed.

SIZES AND CAPACITIES—No. 1 AA unit, 1 ton refrigerating capacity; No. 1½ AA unit, 1¼ tons; No. 4 AA unit, 4 tons; No. 1 AW unit, 1 ton; No. 1½ AW unit, 1½ tons.

MADE BY—*De La Vergne Engine Co., Philadelphia, Pa.*

Orr & Sembower Burner Unit

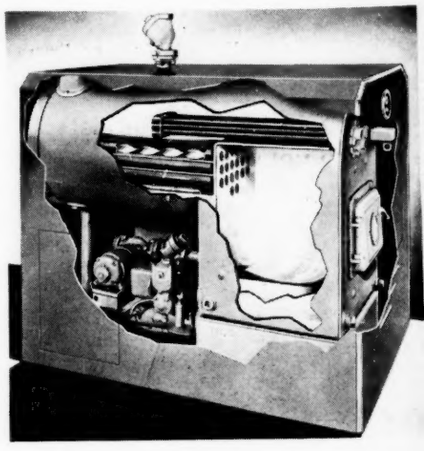
NAME—Oil-O-Matic boiler-burner unit.

PURPOSE—To supply steam and hot water, utilizing oil as a fuel.

FEATURES — Turbulators installed in flue tubes to increase temperance of gases. One piece assembly of base and fire chamber of a moulded refractory. Fire chamber is insulated on all sides with rock wool and mounted on a 2 in. magnesia pad. Steam unit is equipped with a low-water cutout to protect the boiler. Hot water units are equipped with a single flow valve to keep boiler water from circulating through heating system during summer months and with a booster pump to increase circulation through heating system during the winter. Units are equipped with either storage or instantaneous hot water coils.

SIZES AND CAPACITIES — Six sizes from 360 to 1,260 net installed steam radiator surface.

MADE BY—*Orr & Sembower, Inc., Reading, Pa.*



To the Contractor

LOOKING FOR A HEATING SYSTEM WITH A DIFFERENCE

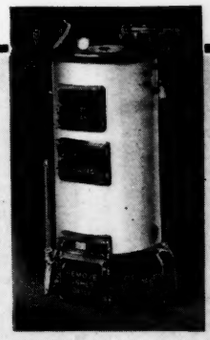
● Crane Boilers — with scores of refinements in design and manufacture—have three outstanding points of superiority. They can be erected in much less time than the ordinary boiler. They have 50 per cent more horizontal "Ceiling" heating surface over the hot gases than ordinary boilers. And patented baffles direct the water across the hottest points.

Quick and easy erection saves time and labor, assures you time and opportunity to make an extra tight job of it. High efficiency reduces your customer's fuel bills, heats every corner of his house. You win . . . and your customer wins . . . when you install a Crane Boiler.

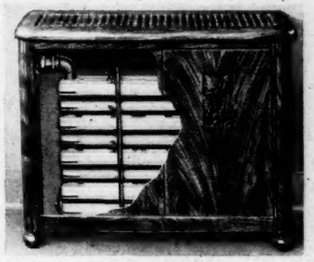
Completing a Crane Heating System with Crane Directed Radiation—the most advanced idea in radiator heat in years—and with Crane Humidifying Radiators—adequate capacity with negligible operating cost—results in a quality job, the long life and efficient operation of which make the most economical heating system to install and to own.

The Crane line is adequate for every residential job. Build your business on Crane Heating Systems . . . and you build profits, volume, and a reputation for sound, efficient installations. Write for full particulars on the Crane line.

The Crane Finance Plan enables your customers to modernize with no money down, three years to pay.

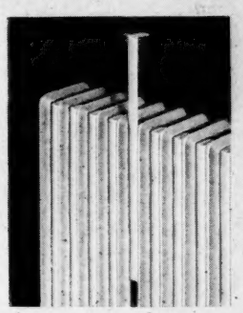


Crane Round Boiler for Coal Burning —the boiler with 24 radical improvements which result in substantial economies and great ease of tending. Readily adapted to oil burning.



Humidifying Radiator Large evaporating capacity in small space. Cabinet enclosure. Easily, quickly installed, replacing ordinary radiation. Practically no operating cost.

S O & W O Sectional Boiler for automatic firing. The SO & WO has super-efficient extended ceiling surface. For oil burner or stoker.



Directed Radiation. Invisible shields direct heat outwardly into room, minimizing ceiling-floor temperature difference, protecting walls, etc. from smudge.

CRANE

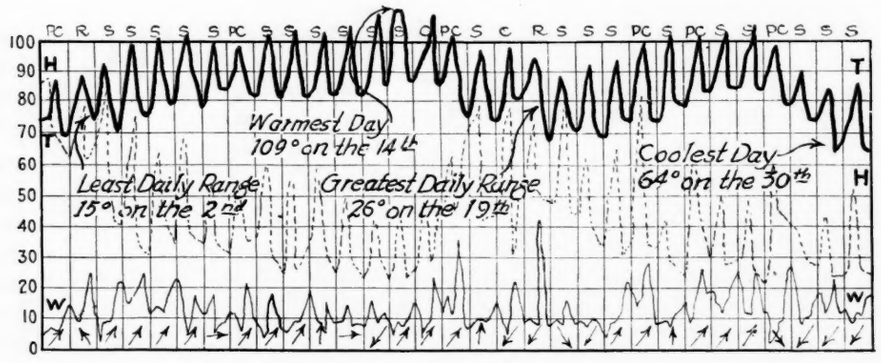
CRANE CO., GENERAL OFFICES: 836 SOUTH MICHIGAN AVENUE, CHICAGO, ILL. • NEW YORK: 23 W. 44TH STREET

Branches and Sales Offices in One Hundred and Sixty Cities

VALVES, FITTINGS, FABRICATED PIPE, PUMPS, HEATING AND PLUMBING MATERIAL

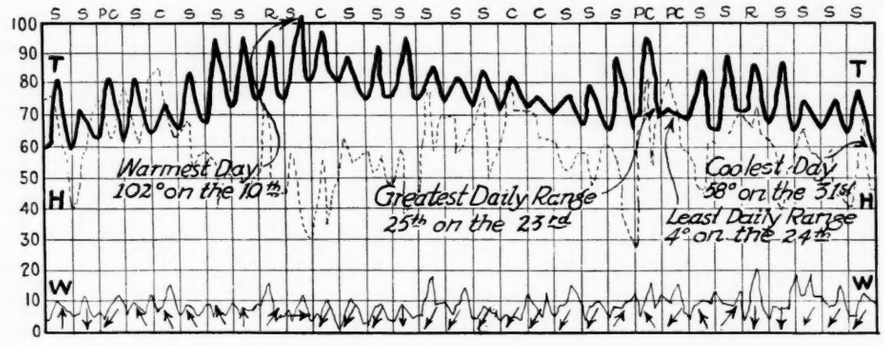
THE WEATHER FOR JULY, 1936

Plotted from records compiled for HEATING & VENTILATING by the U. S. Weather Bureau. Heavy curves (T), dry bulb temperatures in deg. F.; dotted lines (H), per cent relative humidity from readings at 8 a.m., noon, and 8 p.m. Light lines (W), wind velocity in m.p.h. Arrows indicate prevailing wind directions, north being arrow pointing up, etc.; S—clear; PC—partly cloudy; C—cloudy; R—rain; Sn—snow.



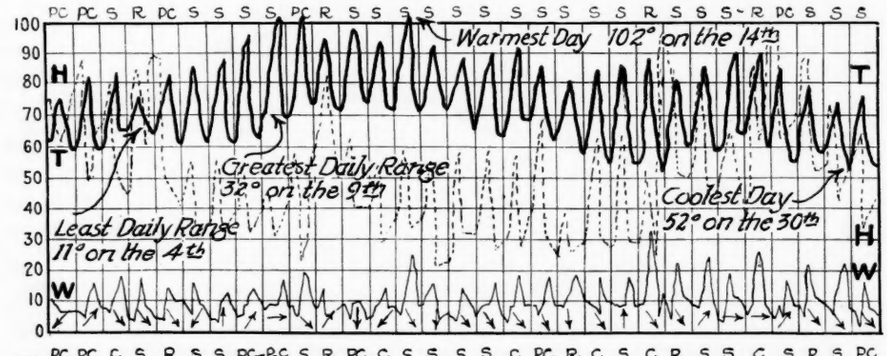
St. Louis

Mean temp. for month, 87.4F; aver. wind velocity, 10.7 m.p.h.; prevailing direction of wind, SW.



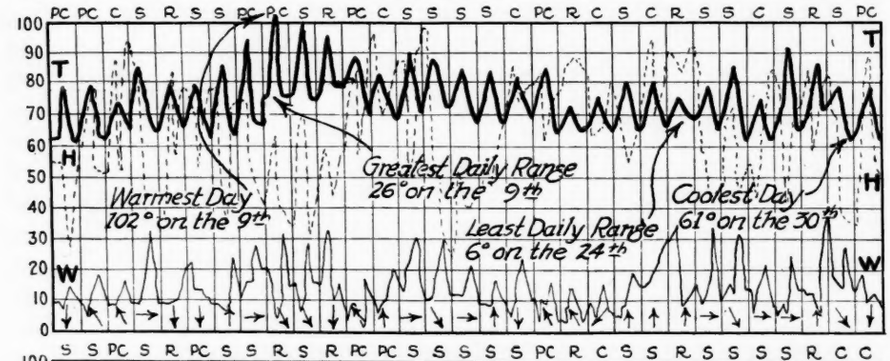
Chicago

Mean temp. for month, 76.8F; aver. wind velocity, 7.1 m.p.h.; prevailing direction of wind, NE.



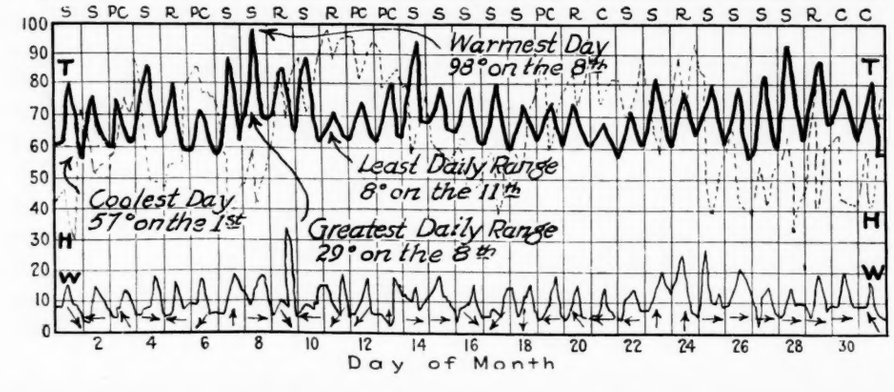
Pittsburgh

Mean temp. for month, 75.0F; aver. wind velocity, 8.7 m.p.h.; prevailing direction of wind, NW.



New York

Mean temp. for month, 74.8F; aver. wind velocity, 12.0 m.p.h.; prevailing direction of wind, N.


Warmest Day
98° on the 8th
Least Daily Range
8° on the 11th
Coolest Day
57° on the 1st
Greatest Daily Range
29° on the 8th
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Day of Month

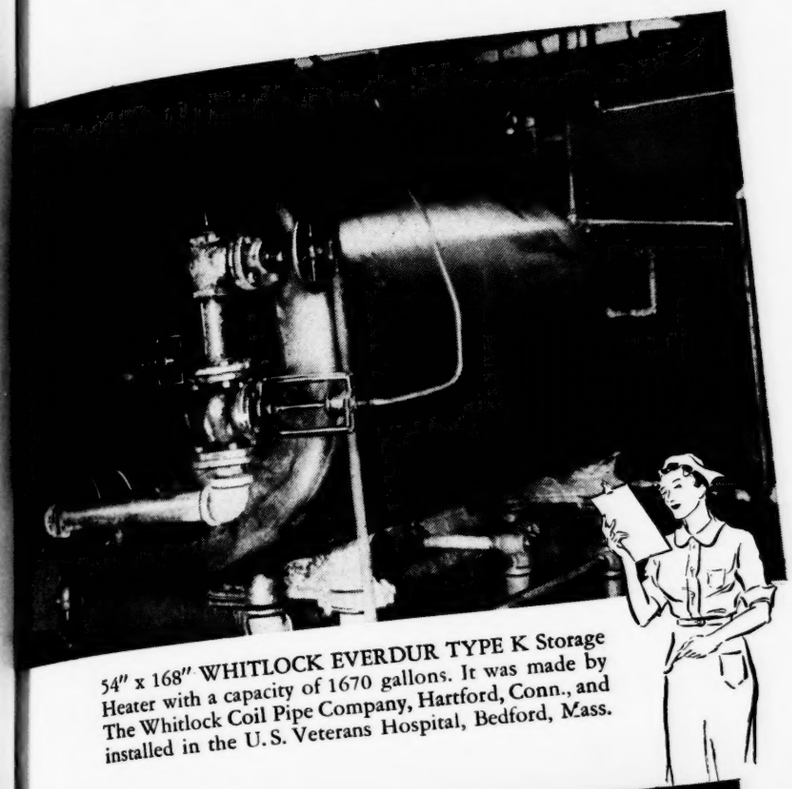
Boston

Mean temp. for month, 71.1F; aver. wind velocity, 9.1 m.p.h.; prevailing direction of wind, W.

Demand for Storage Heaters of Rust-Proof Everdur Metal

(Strengthened Copper)

is increasing!



54" x 168" WHITLOCK EVERDUR TYPE K Storage Heater with a capacity of 1670 gallons. It was made by The Whitlock Coil Pipe Company, Hartford, Conn., and installed in the U. S. Veterans Hospital, Bedford, Mass.

Here are some typical installations!

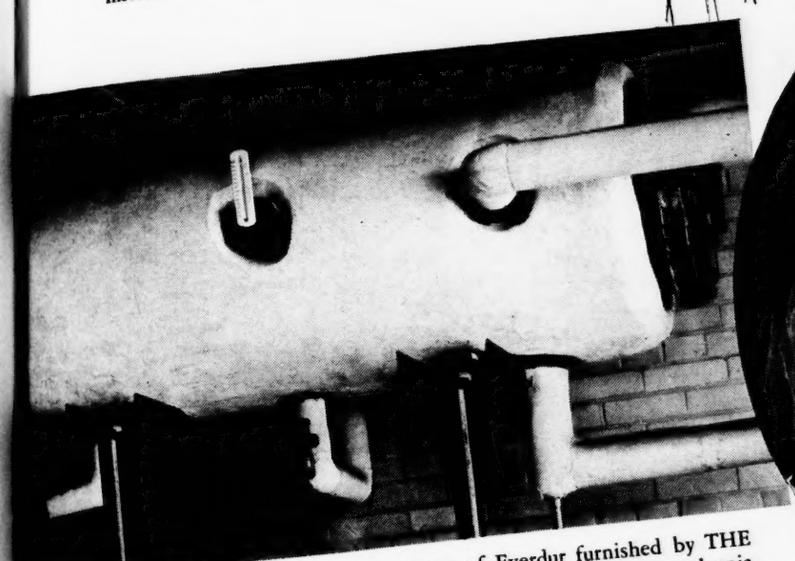
Everdur Heaters provide an abundance of clean, *rust-free* hot water indefinitely...and free owners of all repair and replacement costs due to rust.

THE AMERICAN BRASS COMPANY

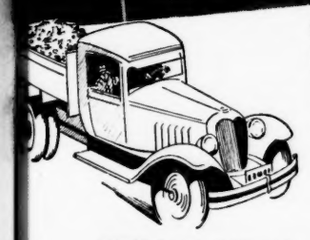
General Offices: Waterbury, Connecticut

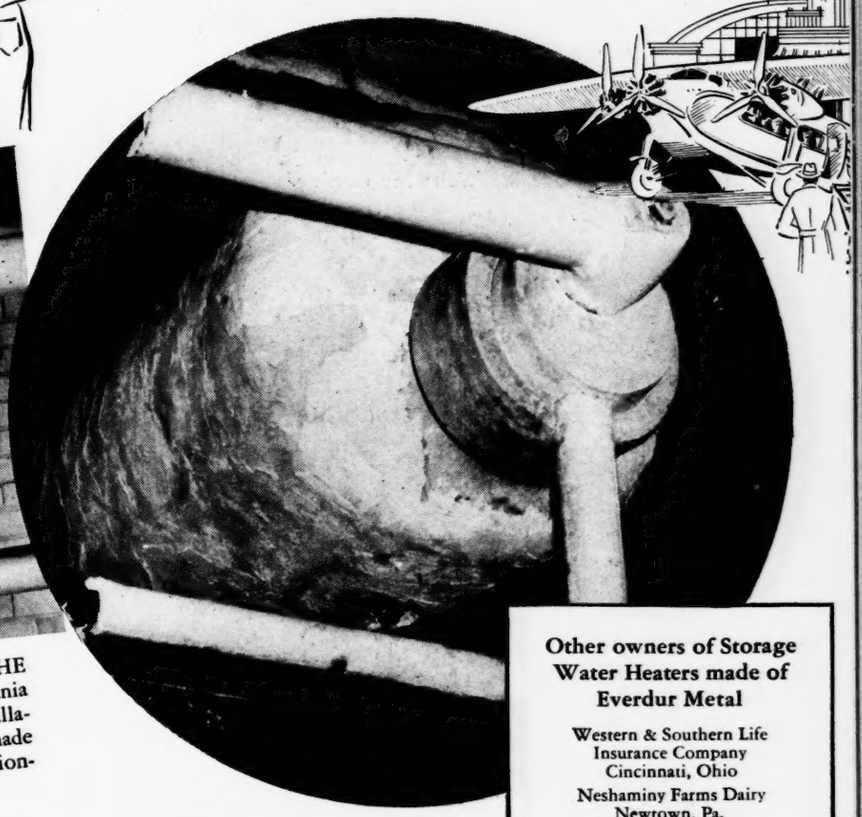
Offices and Agencies in Principal Cities

In Canada: ANACONDA AMERICAN BRASS LIMITED, New Toronto, Ontario



Storage Heater of Everdur furnished by THE SIMS COMPANY of Erie, in the Pennsylvania State Highway Garage at Erie. Similar installations of Sims Everdur Heaters have been made at Mercer, Kittaning, St. Mary's, Indiana, Uniontown, and Lebanon, Pa.





This 30" x 96" PATTERSON EVERDUR Storage Heater has a rated heating capacity of 600 gallons per hour. Of welded construction throughout, it was designed and fabricated by Patterson-Kelley Co., Inc., E. Stroudsburg, Pa., for Floyd Bennett Airport, Brooklyn, N. Y.

Other owners of Storage Water Heaters made of Everdur Metal

Western & Southern Life Insurance Company
Cincinnati, Ohio

Neshaminy Farms Dairy
Newtown, Pa.

Palatine Hotel
Newburgh, N. Y.

Miami University
Oxford, Ohio

Home of the Daughters of Jacob
New York City

Davis Laundry & Cleaning Company
Cleveland, Ohio

Lenox Laundry
Mount Vernon, N. Y.

U. S. Post Office
Burlington, N. J.

U. S. Post Office
Mount Vernon, N. Y.

U. S. Parcel Post Building
Detroit, Michigan

Myron Stratton Home
Colorado Springs, Colo.

EVERDUR METAL—"Everdur" is a registered trade-mark identifying products of The American Brass Company made from alloys of copper, silicon and other elements.

ANACONDA
from mine to consumer
REG. U.S. PAT. OFF.
36151

Everdur Metal for Tanks

A COPPER ALLOY WITH THE STRENGTH OF STEEL

End the Nightmare of Heavy

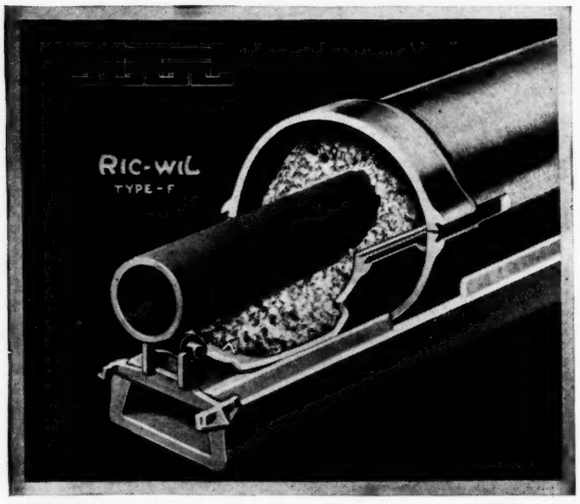
STEAM LOSS!

DOES the familiar ghost of escaping Steam haunt your dreams of lower power costs? If you are conveying Steam underground, in an inadequate or outmoded system—better check up on it. About the time you think you've got this ghost buried, he goes on the loose again—and throws fits into your operating costs—with resulting heat loss, fuel waste, boiler forcing, and inadequate steam supply.

Ric-wiL Conduit is tailor-made for just this sort of thing. A correctly engineered system, it will keep your steam lines (present or contemplated) tight, dry and 90%—efficient. Obtainable in a variety of designs and materials, it secures maximum results on any problem of underground steam transmission. Insulation is the famous Ric-wiL Watertight Asbestos Dry-paC (other insulations optional). Installation instructions and engineering service drawings furnished—also field supervision if desired. Write for catalog.

The RIC-WIL Co., Union Trust Bldg., Cleveland, Ohio
New York **San Francisco** **Chicago**
Agents in principal cities

According to competent authorities, heat loss from conduit in wet soil is over four times that in dry soil. Ric-wiL External Underdrain keeps the soil *dry*.



REGISTERED IN U. S. PATENT OFFICE

RIC-WIL

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

Heating Index Reflects Best Business Since 1929

(Concluded from page 33)

an 80-ton job in a general office and a 50-ton installation in a theater.

Value of wholesale trade increased noticeably in June from the same month a year ago and collections on accounts receivable were made at a higher rate over this period, according to reports of wholesalers in the monthly joint study of the National Association of Credit Men and the Department of Commerce.

Of the 19 classifications of different kinds of wholesalers, those engaged in jobs of plumbing and heating equipment lead all others in the percentage of the sales increase for June as compared with a year ago, the gain being 60.7% for plumbing and heating jobbers as compared with an average of only 18.8% for all types of wholesalers. A similar study being carried on by the same organizations indicates that sales of manufacturers of stoves, ranges or steam heating equipment increased 47% in June as compared with a year ago, while manufacturers from 15 other industries showed an average increase of only 32.8%.

Degree-Days Page Mr. Consumer

(Concluded from page 34)

people had a measure of the weather. They used Degree-Days to gauge how much fuel they should use.

This case shows what can be done if the Degree-Day unit is taken out of its engineering cage and given to the public. The heating industry generally can benefit by following a carefully prepared program to acquaint the public with this unit of measure, a unit taught in few schools, although it concerns our every-day lives to a greater extent than many of the units that Mr. Consumer had to learn along with his "three R's."

What Readers Say

(Concluded from page 58)

as well as a supply of air. The idea in designing coal-burning boilers and furnaces, therefore, has been to give the distilled gases plenty of space in which to get a chance to mix with the air for perfect combustion, and also to keep the heat-absorbing surfaces well away from the area where the distillation takes place. A well-tended coal fire burns with a very high temperature after it once gets going, and a considerable fraction of the heat is in the form of radiant heat, especially with coke and some forms of bituminous coal. This is also the case where a stoker is used and primary air is forced through the fuel bed under power. The result is that most boilers and furnaces for burning coal have a large volume above the fuel bed which has the effect of placing the heat-absorbing surfaces away from the bed and at the same time an attempt is made to let a good part of the total absorbing surface "see" the flame in order to absorb radiant heat.

WITH THE MANUFACTURERS

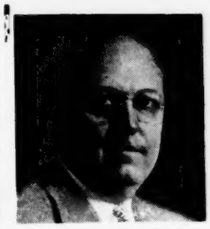
American Gas Products Corp., Div. American Radiator & Standard Sanitary Corp., New York, has appointed **Kenneth Chamberlain** sales representative in its Boston territory. Mr. Chamberlain for the past 17 years was connected with the Gas Light Company of Worcester, Mass., in a sales and engineering capacity.

Chicago Pump Co., Chicago, Ill., has appointed **L. J. Tierney Co.**, 1325 Statler Bldg., Boston, Mass., as New England distributor of its complete line.

De Bothezat Division, American Machine and Metals Mfg. Corp., New York, has appointed **V. L. Sanderson**, 1108 Otis Bldg., Philadelphia, Pa., as exclusive representative in southeastern Pennsylvania, Delaware, and southern New Jersey. Mr. Sanderson already represents American District Steam Co. and Ajax Flexible Coupling Co., and is developing a sales service on steam distribution, heating, ventilating, and power transmission.

The Emerson Electric Mfg. Co., St. Louis, Mo., announces the appointment of the following: **R. E. Otto** as manager of motor sales; **John Wright**, manager of fan sales; **O. D. Metz**, assistant manager of motor sales; **Val. J. Maurer**, manager, New York offices; **E. E. Harwood**, motor sales staff, New York office.

R. E. Otto



John Wright

Fisher Governor Co., Marshalltown, Iowa, has appointed **General Meters & Controls Co.**, formerly General Instruments & Controls Co., as its direct factory representative in Chicago. The company is located at 205 West Wacker Drive.

Inland Steel Co., Chicago, has appointed **Peter M. Lorenz** district sales manager of its St. Louis office. He has been associated with Inland since 1910. **Frederick A. Ernst** has been named assistant manager.

The Insulite Co., Minneapolis, Minn., has appointed **C. F. Heym** assistant sales manager of the southern district, with headquarters at 1100 S. Vandeventer Ave., St. Louis. **E. A. Anderson** has been appointed sales manager of the northwest sales district, with headquarters at the Builders Exchange Bldg., Minneapolis. The Public Relation Branch of the sales department was created in July, reporting to the executive sales branch. **Joe Sanders, Jr.**, was appointed assistant to vice-president, public relations, with headquarters at 205 W. Wacker Drive, Chicago.

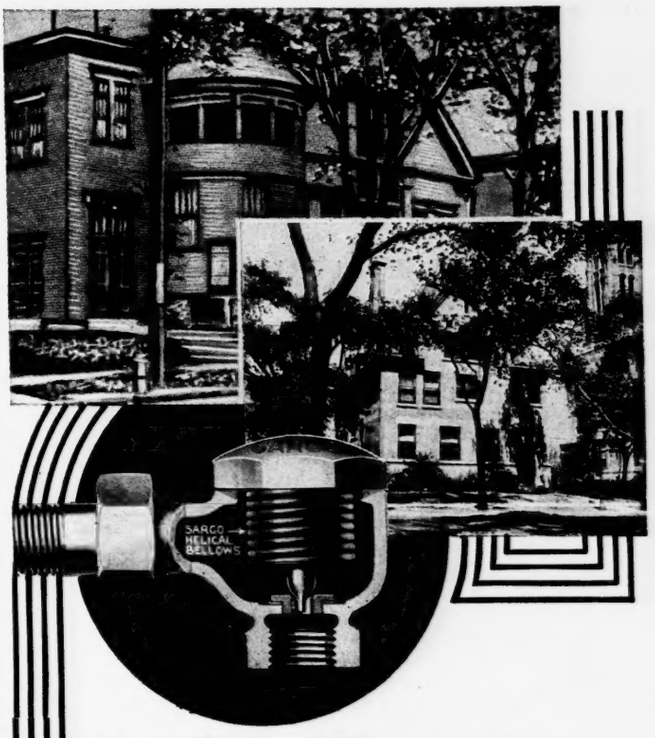
Iron Fireman Manufacturing Co., Portland, Oreg., has erected two additional units to its plant, increasing its production 50%.

Kelvinator Corp., Detroit, Mich., has appointed the following distributors for its commercial line: **Gambill Co., Inc.**, Chicago; **Nichols Bros.**, Adrian, Mich.; **Electric Supply Co.**, Corpus Christi, Tex.; **R. W. Barnes**, San Antonio, Tex.; **New York State Electric and Gas Co.**, Binghamton, N. Y.; **F. H. Higgins**, Ithaca, N. Y.; **Newport Coal Co.**, Newport, R. I.; **A. H. Lumm Co.**, Toledo, Ohio.

The Ohio Electric Mfg. Co., Cleveland, Ohio, has appointed J. L. Vergilio Co., 942 Prospect Ave., Cleveland, sales agent for northern Ohio. **J. L. Vergilio** and **D. S. Cole** are in charge.

Perfex Controls Co., Milwaukee, Wis., recently formed company manufacturing a complete line of automatic controls, has opened the following offices, which are under the direction of the men listed: New York—**Shepard Barnes**, vice-president in charge of eastern territory, 202 East 44 St.; Philadelphia—**C. Ellis Hayes**, manager, Philadelphia division, 3701 N. Broad St.; Boston—**Charles B. Soper**, manager, New England division, 131 Clarendon St.; Chicago—**Allen Butler**, manager, midwestern division, 500 N. Dearborn St.; Dayton—**W. W. Boes**, Mutual Home Bldg.; Detroit—**E. Harold Clark**, 600 Michigan Theater Bldg.; San Francisco—**P. J. O'Meara Co.**, 50 Hawthorne St.; New Orleans—**O. E. Lewis Co.**, 732 Camp St. **W. R. Miller**, formerly with the Chicago office of Minneapolis-Honeywell, is in charge of the field research engineering.

(Concluded on page 80)



Small Buildings, too, heated more comfortably and cheaply with . . .

SARCO Heating System

For years we have shown you skyscraper after skyscraper equipped with the Sarco Heating System. But the Sarco is heating hundreds of homes and small buildings just as efficiently as larger structures.

When you have a heating problem to solve, why not talk it over with us. Our experienced engineers have to guide them the data of an organization that has solved hundreds of difficult and unusual heating problems during the past quarter of a century. A few minutes spent with one of our men may give you an idea that would save your client a lot of money and provide a more efficient heating system.

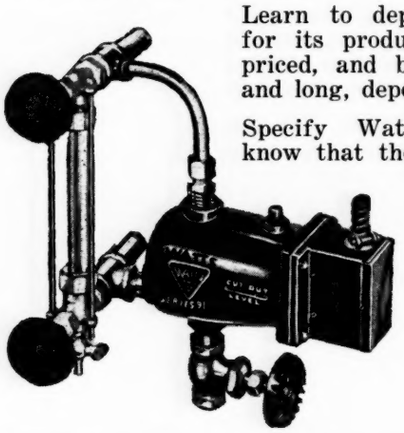
The Sarco line of heating specialties includes radiator traps, combination float and thermostatic traps, packless inlet valves, return traps, water blenders, temperature regulators, strainers, air eliminators, high pressure traps and pipe savers. ***Write for our catalog P-45.***

SARCO CO., INC.
183 Madison Ave., New York, N. Y.
Branches in Principal Cities
Sarco Canada Limited, Federal Bldg., Toronto, Ont., Canada.

SARCO HEATING SYSTEMS

WATTS *Gives you the Latest!*

. . . in engineering and design, of Pressure, Temperature and Vacuum Relieving Devices; Boiler Water Controls and Cut-offs.



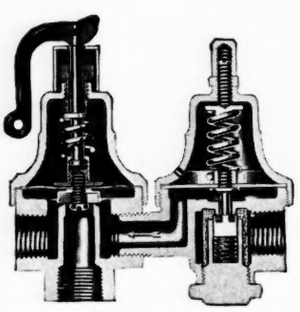
Learn to depend upon Watts, for its products are favorably priced, and built for efficiency and long, dependable service.

Specify Watts products and know that they will live up to their . . . LEADERSHIP . . . reputation.

No. 94
Low Water Cut-off

Compact, efficient, a novel type of low water cut-off design. Simple to install; positive in action; profitable to handle. A quality engineered, quality built unit with a price appeal.

No. 450 (Right)
Hot Water Heating Regulator



Built of composition BRONZE and other high grade materials. The lowest priced, quality unit on the market.

Completely efficient; built to Watts standards.

No. 20 Pres-Tem-Vac

Pressure, temperature and vacuum Relief Valve. Semi-automatic. Completely accessible.

AND THE MOST COMPLETE LINE OF: Feeders, Low Water Cut-offs; Reducing Valves, Pressure, Temperature and Vacuum Relief Valves and Water Circulators in the world.

Ask for Complete Information

SPECIFY WATTS UNITS

WATTS
REGULATOR COMPANY
Lawrence, Mass.

REPRESENTATIVES IN ALL PRINCIPAL CITIES

Republic Steel Corp., Cleveland, Ohio, has appointed **Hoyle Jones** district sales manager with headquarters in Tulsa, Okla. C. S. Powers, former district manager, died recently.

Spencer Heater Co., Williamsport, Pa., has appointed **J. E. Axeman**, general sales manager. Associated with Spencer since 1926, Mr. Axeman served successively as sales representative in the Buffalo and Rochester territories and as branch manager of the Baltimore-Washington territory. Mr. Axeman is a graduate of Pennsylvania State College. He succeeds F. W. Earnest, Jr., who resigned to accept the presidency of Anthracite Industries, Inc.

J. E. Axeman

H. A. Thrush & Co., Peru, Ind., has appointed **Blaine H. Moke** factory sales representative in charge of the eastern trailer display unit.

E. S. White

U. S. Radiator Corp., Detroit, has elected **Henry T. Cole**, formerly president of the corporation, chairman of the board, and **Elwood S. White**, president.

Mr. White joined the corporation April 1, 1936, as chairman of the operating committee after having served as president of Taco Heaters, Inc. For more than 25 years Mr. White has been connected with the boiler and radiator industry.

Worthington Pump and Machinery Corp., Harrison, N. J., has appointed **Thomas Cruthers** vice-president of the corporation. He has been associated with Worthington since 1907.

NEW CATALOGS

Anchor Stove & Range Co., Inc., New Albany, Ind. Five standard-size bulletins, describing the Anchor line of bituminous and anthracite stokers. Bulletin 16-B-36 describes the complete line of both bituminous and anthracite stokers, while bulletins 1236, 536, 636 and 336 apply only to domestic cabinet type bituminous stokers, commercial and industrial types, anthracite stokers and heavy duty industrial models, respectively.

The Barber Gas Burner Co., 3702 Superior Ave., Cleveland, Ohio, has published a standard-size, loose-leaf catalog, No. 37, describing the Barber line of gas conversion burners, burner units, pressure regulators, gas shut-off valves, and control equipment. A large amount of engineering data relating to gas equipment is included in this 44-page catalog.

The Bristol Co., Waterbury, Conn., has published Bulletin 436, covering a new line of round chart recording voltmeters and ammeters for electric utilities and industrial plants. Models for wall, switchboard, flush panel, and pole mounting, as well as for portable use, are illustrated with drilling dimensions.

Combustion Engineering Co., Inc., 200 Madison Ave., New York, has published a 24-page, standard-size catalog describing its CE-Skelly stoker unit. This stoker is designed for burning all grades of bituminous coal and is applicable to all types of boilers ranging from small heating units to power boilers up to 400 hp.

Julien P. Friez & Sons, Inc., Baltimore St. and Central Ave., Baltimore, Md., has published an attractive bulletin on the controls which it offers for air conditioning. Standard size, 16 pages. The publication is intended to show a wide application of temperature, humidity, and effective temperature controlling, indicating, and recording instruments, as applied to a varied field of air conditioning. This bulletin also commemorates the company's 60th anniversary.

The B. F. Goodrich Co., Akron, Ohio, has published a 27-page illustrated catalog, No. 2180, which gives a complete description of its line of Longlife fractional horsepower V belts and their application. A feature of the catalog is a set of tables occupying 10 pages which gives the center distances for standard Goodrich belts for various speed ratios, motor speeds, and pulley diameters.

Gorton Heating Corp., Cranford, N. J., has published a four-page, standard-size bulletin, No. 103, describing a method developed by the company for changing a hot water heating system to a Gorton vapor equalizing system. The bulletin also describes two types of valves and air eliminator.

Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, has published Catalog 436 and Instruction Book 436A. Both of these books are standard-size and have heavy paper covers. Catalog 436 has 32 pages and gives complete specification and descriptions of the Ilg line of air conditioning equipment, including Spot-Koolers, Kold ceiling type units, floor type air conditioning units, and condensing units. The instruction bulletin has 64 pages, and is written so as to make the problem of air conditioning estimating as simple as possible, while avoiding rule-of-thumb methods. It lists a number of reasons for and rules pertaining to the correct planning of systems for comfort and health. It also gives a number of suggestions for installing, operating, and servicing air conditioning installations.

Kewanee Boiler Corp., Kewanee, Ill., has published a standard-size catalog, No. 80, covering its line of steel boilers. Complete specifications and a schedule showing the principal dimensions are given for its complete line of boilers. Also included are details on indirect hot water heating coils, water heaters, water heating garbage burners, and steel tanks.

The Kropp Forge Co., Chicago, Ill., has published a 24-page, standard-size bulletin, No. 125, describing the Kropp line of flanges. This stock flange list includes dimension, weights, and prices on standard flanges in all sizes from ¾ in. to 24 in., and engineering data on standard flange facings, drilling templates, pressure-temperature ratings, etc. The type of flanges offered include standard, extra heavy, double hub, and high hub boiler flanges, welding flanges, reducing companion flanges, and blind flanges.

Monmouth Products Co., 205 East 131 St., Cleveland, Ohio. A standard-size, 16-page booklet entitled "The Science of Re-Humidifying Indoor Air." Explains the principles of humidifying indoor air and discusses various types of humidity controls. Also gives data on calculating humidification requirements. This company has also published a four-page, standard-size bulletin describing its Automatic June humidifying system.

Perfex Controls Co., 415 W. Oklahoma Place, Milwaukee, Wis., has published a complete catalog covering the entire Perfex line of automatic control equipment for heating, air conditioning, and refrigeration.

Preferred Utilities Manufacturing Corp., 33 W. 60th St., New York, N. Y. This is the 1936-1937 edition of the Preferred Utilities catalog listing all the types of equipment which they offer for automatic heating and air conditioning. The catalog covers practically a complete line of equipment which is used in this work. Some of the items offered by this company are controls, grilles, various types of asbestos and firebox cements, copper tubing and fittings, expansion tanks, fuel oil heaters, boiler insulation, fuel oil pumps, smoke bombs, oil strainers, and a large variety of valves. A rather complete data section on heating and air conditioning is included in the back of this book. This section covers approximately 12 pages. Price, $1.00.

Republic Steel Corp., Cleveland. The fourth edition of "Toncan Iron Pipe for Permanence" is being currently distributed. This 64-page book is profusely illustrated with test charts and tables and incorporates new sections dealing with threading, air conditioning, industrial maintenance and process uses, and brewing and distilling ap-

(Concluded on page 82)

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plications. Augmenting the test charts in showing the merits of Toncan copper molybdenum pipe is a list of photographs showing the applications for which this type of pipe is being utilized.

J. E. Rhoads & Sons, 35 N. Sixth St., Philadelphia, Pa. A four-page, standard-size booklet describing the various types of Rhoads leather belting.

Sterling Engineering Co., 3738 North Holton St., Milwaukee, Wis. A standard-size, 8-page, loose-leaf bulletin, No. 234-A, describing the equipment offered for use with steam heating systems. Describes thermostatic, float, blast and boiler return traps, vents, radiator supply valves, check valves, orifices and water and vacuum gages.

The Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio, has published Bulletin V-100-B which discusses the problem of ventilation in industrial and commercial buildings. The bulletin is standard-size and has 15 pages. Included is information on ventilation methods, air requirements, method of estimating sizes and numbers of ventilators as well as data on the Swartwout rotary ventilator and the Swartwout Dexter heat valve.

The Trane Co., La Crosse, Wis. A 16-page bulletin describing the company's residential heating and air conditioning systems. Contains data for engineer, architect, and contractor.

The Trane Co., La Crosse, Wis. Standard-size, loose-leaf, eight-page bulletin, No. 230, describing 1936 model of the Trane Climate Changer for residences and small buildings. Gives construction details and technical data on heating and cooling capacities as well as roughing-in dimensions.

Tube-Turns, Inc., 425 Fifth St., Louisville, Ky. A standard size, 48-page catalog and price list No. 107. Profusely illustrated. Includes complete descriptive, dimensional, capacity, and price data on the company's complete line of fabricated fittings, together with typical installation photographs.

Western Rotary Ventilator Co., Inc., 1720 East 14 St., Los Angeles, Calif. Three standard-size, loose-leaf sheets describing the company's rotary turbine ventilator, rotary fan ventilator, and propeller type exhaust fan.

Westinghouse Electric & Mfg. Co., Mansfield, Ohio. Two standard-size bulletins describing the SW-06 Mobilaire air conditioning unit. The first bulletin has four pages and describes the essential features of the unit. The second bulletin has two pages and gives a detailed statement of operating data of the unit.

The Will-Burt Co., Orrville, Ohio. A standard size, eight-page booklet devoted to the company's commercial stokers, available for apartments, churches, stores, and other large buildings.

COMING EVENTS

OCTOBER 26-30, 1936. EIGHTEENTH ANNUAL CONVENTION OF AMERICAN GAS ASSOCIATION, *Atlantic City, N. J.*

NOVEMBER 30-DECEMBER 4, 1936. FIFTY-THIRD ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, *Engineering Societies Bldg., New York.*

NOVEMBER 30-DECEMBER 5, 1936. 12TH NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING, *Grand Central Palace, New York.*

DECEMBER 2-4, 1936. 32ND ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF REFRIGERATING ENGINEERS, *New York.*

DECEMBER 15-17, 1936. WINTER MEETING OF THE NATIONAL WARM AIR HEATING AND AIR CONDITIONING ASSOCIATION, *Stevens Hotel, Chicago, Ill.*

JANUARY 25-27, 1937. 43RD ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, *St. Louis, Mo.*

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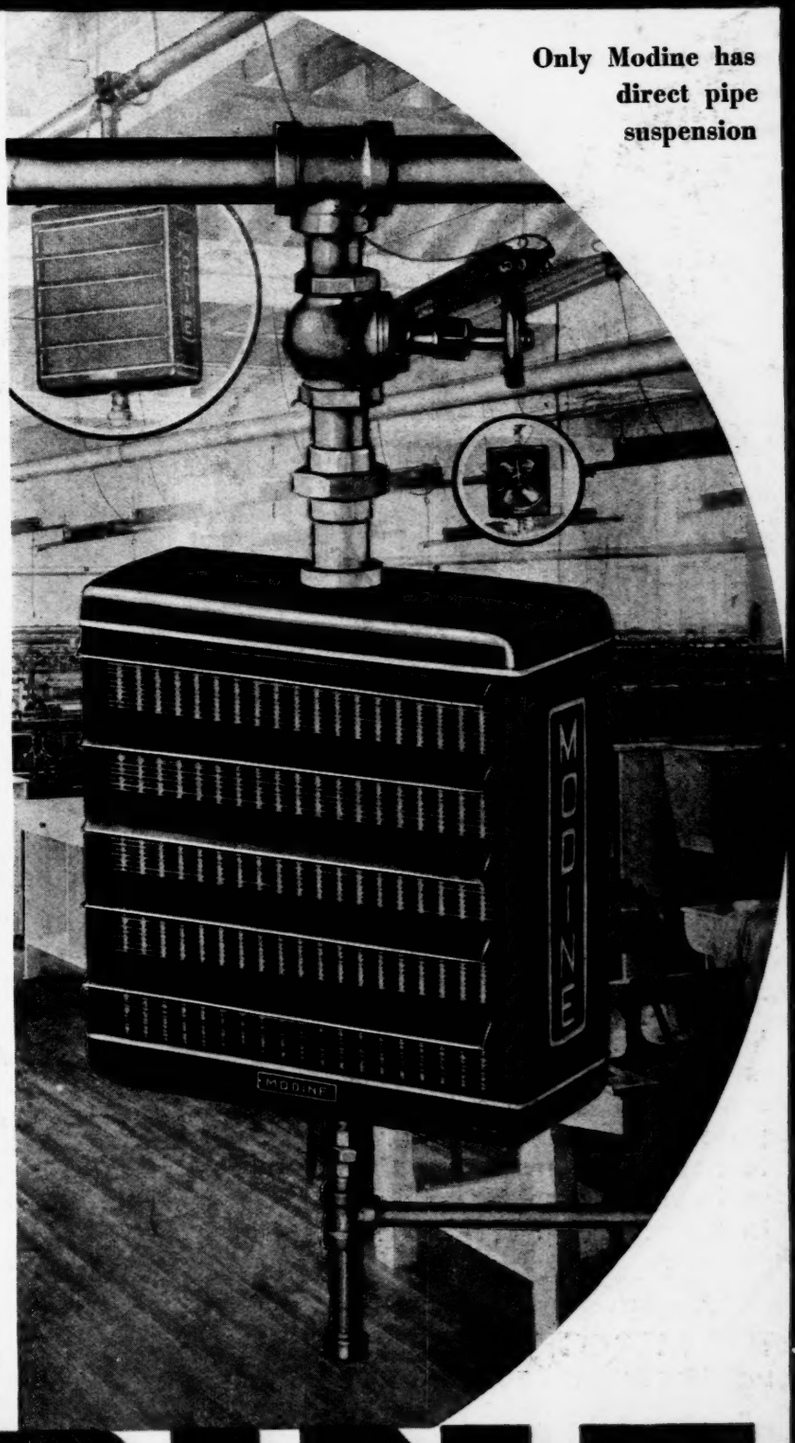

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